Guide to the Geology of the Lewistown–Spoon River Area

Fulton County, Illinois

David L. Reinertsen
Russell J. Jacobson
Myrna M. Killey
Robert S. Nelson
Philip C. Reed

Field Trip Guidebook 1993B May 22, 1993
Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY

Cover photo Pennsylvanian Tradewater Formation strata exposed in the south bank of Spoon River east of the bridge at Duncan Mills (photo D. L. Reinertsen).

Geological Science Field Trips The Educational Extension Unit of the Illinois State Geological Survey conducts four free tours each year to acquaint the public with the rocks, mineral resources, and landscapes of various regions of the state and the geological processes that led to their origin. Each field trip is an all-day excursion through one or more Illinois counties. Frequent stops are made to explore interesting phenomena, explain processes that shape our environment, discuss principles of earth science, and collect rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers preparing earth science units. Grade school students are welcome, but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for each ten students.

Field trip guide booklets are available for planning class tours and private outings. For a list, contact the Educational Extension Unit, Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820-6964. Call (217) 333-4747 or 333-7372.

printed on recycled paper

Printed by authority of the State of Illinois / 1993 / 500

Guide to the Geology of the Lewistown–Spoon River Area

Fulton County, Illinois

David L. Reinertsen
Russell J. Jacobson
Myrna M. Killey
Philip C. Reed
Illinois State Geological Survey
Robert S. Nelson
Illinois State University

Field Trip Guidebook 1993B May 22, 1993

ILLINOIS STATE GEOLOGICAL SURVEY
Morris W. Leighton, Chief
Natural Resources Building
615 East Peabody Drive
Champaign, Illinois 61820-6964

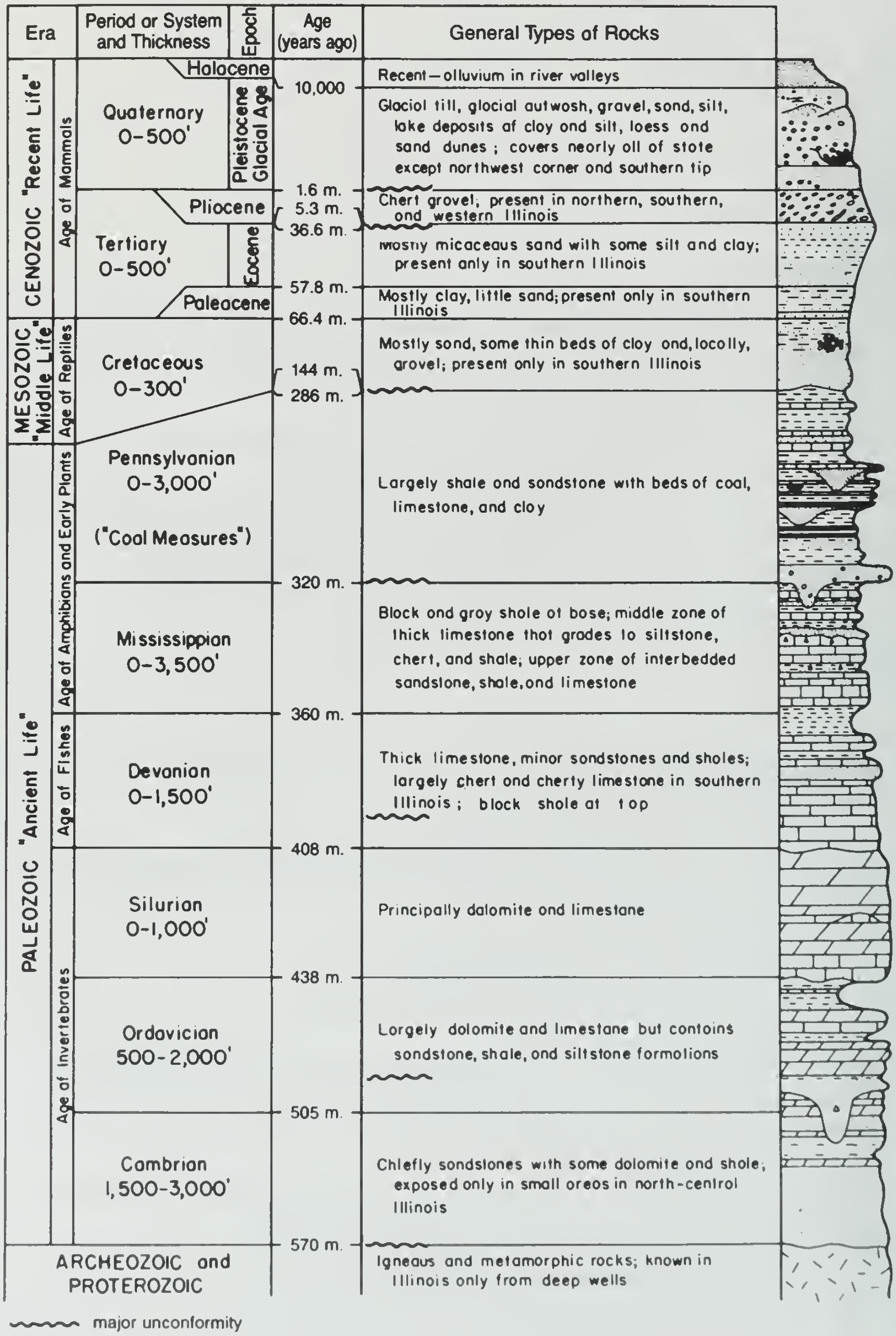
CONTENTS

LEWISTOWN–SPOON RIVER AREA 1
GEOLOGIC HISTORY 1
Precambrian Era 1
Paleozoic Era 3
The geologic column 5
Geologic framework of the field trip area 6
Mesozoic and Cenozoic Eras 6
Quaternary geology 9
GEOMORPHOLOGY 12
Physiography 12
Drainage 14
Relief 14
MINERAL RESOURCES 15
Groundwater 15
Mineral Production 16
GUIDE TO THE ROUTE — STOPS 17
1 Pennsylvanian Lower Tradewater strata exposed in south bank of Spoon River 20
2 Pennsylvanian Tradewater strata, recent slumping, and stream piracy at Tater Creek 22
3 Discussion of Spoon River Valley and recent slumping 24
4 Lunch at Bernadotte at grist mill site 27
5 Road damage from slumping on south Spoon River Valley wall east of Bernadotte 28
6 Gravel pit in Pleistocene terrace deposits near Seville 32
7 Middle Tradewater strata exposed in Topeka, Peoria and Western Railway cut 34
8 Tradewater strata and recent slumping on north side of Shaw Creek 37
9 Massive recent slumping along State Route 9 east of Spoon River 40
10 Pleistocene Hulick Till and Peoria Loess at north end of Mt. Pisgah 44
11 Spoon River Valley at Mt. Pisgah near Ellisville 45
BIBLIOGRAPHY 46
GLOSSARY 48

FIGURES

Generalized geologic column showing succession of rocks in Illinois iv
1 Illinois county boundaries as of 1823 2
2 Location of some of the major structures in the Illinois Basin 3
3 Generalized columnar section of exposed strata and strata penetrated in wells 4
4 Stylized north-south cross section showing structure of the Illinois Basin 5
5 Structural features of Illinois 7
6 Bedrock geology beneath surficial deposits in Illinois 8
7 Generalized map of glacial deposits in Illinois 10
8 Generalized columnar section of Pleistocene deposits 11
9 Physiographic divisions of Illinois 13
10 Stratigraphic column of the Lower Tradewater Formation exposed at Stop 1 20
11 Stratigraphic column of the Tradewater Formation exposed at Stop 2 22
12 Major components of a slump-type landslide 23
13 Spoon River watershed map 25
14a Breeched berm at downstream edge of lane which is eroded in foreground 26
14b Breeched berm with a narrow ledge of the lane to the left 26
15a Water disappearing through crack in concrete ditch liner 30
15b Holes caused by piping along side of concrete ditch liner 30
16 Generalized stratigraphic section of strata exposed at Stop 7 35
17a Pennsylvanian Seville Limestone exposed west of Seville 36

17b Siltstone and silty sandstone exposed west of Seville Limestone in figure 17a 36
18 Generalized stratigraphic section of the Tradewater Formation exposed at Stop 8 38
19a Exposure of Bernadotte Sandstone and Pope Creek (?) Coal, north side of Shaw Creek 39
19b Typical hummocky topography of earth slump east of figure 19a 39
20a Numerous slump scarps exposing Hulick Till Member at Stop 9 east of Spoon River 43
20b Deformation of rock armor along toe of slump at Stop 9 43



Generalized geologic column showing succession of rocks in Illinois.

LEWISTOWN–SPOON RIVER AREA

The southeastern part of the Galesburg Plain, a relatively level to slightly rolling surface developed by Illinoian *glaciers** perhaps 250,000 years ago, is the geologic setting for the Lewistown–Spoon River field trip. Since that time, the entire area has been eroded and covered by windblown silt called loess (rhymes with bus).

Strata of Pennsylvanian age, including several important minable coals, underlie the Lewistown-Spoon River area. Mining of the Rock Island Coal Member (Tradewater Formation) and younger coals of the Carbondale Formation, especially the Colchester, Springfield, and Herrin Coal Members, made Fulton County an important coal-producing area for many years.

After the Revolutionary War (1775-83), the Northwest Ordinance (1787) established the Northwest Territory, which encompassed modern Illinois, Indiana, Michigan, Ohio, Wisconsin, and part of Minnesota. Fifteen counties had been formed in the Illinois Territory by the time statehood was attained on December 3, 1818. Fulton County, named for the inventor of the steamboat, was the 14th county established (January 28, 1823) after statehood. From the Illinois River northward, Fulton County embraced an area along its present western boundary to the Mississippi River, northeastward along the Illinois River into modern Will and Cook Counties, and north to the Wisconsin border (fig. 1). During January 1825, the modern boundaries of the county, enclosing an area of 864 square miles, were established.

On the Lewistown–Spoon River field trip, we will travel through a part of west-central Fulton County. The area is about 170 miles southwest of downtown Chicago and some 50 miles northwest of Springfield and was immortalized by the American poet Edgar Lee Masters in his *Spoon River Anthology*.

GEOLOGIC HISTORY

Precambrian Era

The Lewistown–Spoon River area, like most of the midcontinent, has undergone many changes throughout the thousands of millions of years of geologic time. The oldest rocks beneath us on the field trip belong to the ancient Precambrian (Archeozoic and Proterozoic) basement complex (see generalized geologic column on facing page). We know relatively little about these rocks from direct observation because they are not exposed at Earth's surface anywhere in Illinois. Only a few drill holes have been drilled deep enough in Illinois for geologists to collect samples of Precambrian rocks; none have been drilled deep enough in Fulton County. Drilling records from wells in nearby areas that did reach the Precambrian indicate that these rocks in the field trip area range from about 3,900 feet deep in the northwest to more than 4,400 feet below the surface toward the east-southeast in the county. These rocks are buried more than 12,500 feet deep some 200 miles to the east-southeast in Hamilton County, Illinois, and may be as much as 17,000 feet beneath the surface in the deepest part of the Illinois Basin.

From the available samples, we know that these ancient rocks consist mostly of *igneous* and *metamorphic, crystalline* rocks of granitic composition. The rocks formed about 1.5 to 1.0 billion years ago when molten materials slowly solidified deep within the earth. By about 0.6 billion years ago, deep weathering and erosion had exposed the ancient rocks at the surface, forming a landscape probably similar to part of the present Missouri Ozarks. We have no rock record in Illinois for the long interval of weathering and erosion that lasted from the time Precambrian rocks were formed until Cambrian *sediments* were deposited across the older land surface. The interval was longer, however, than the span of geologic time from the Cambrian to the present.

---

*Words in italics are defined in the glossary in the back of the guidebook

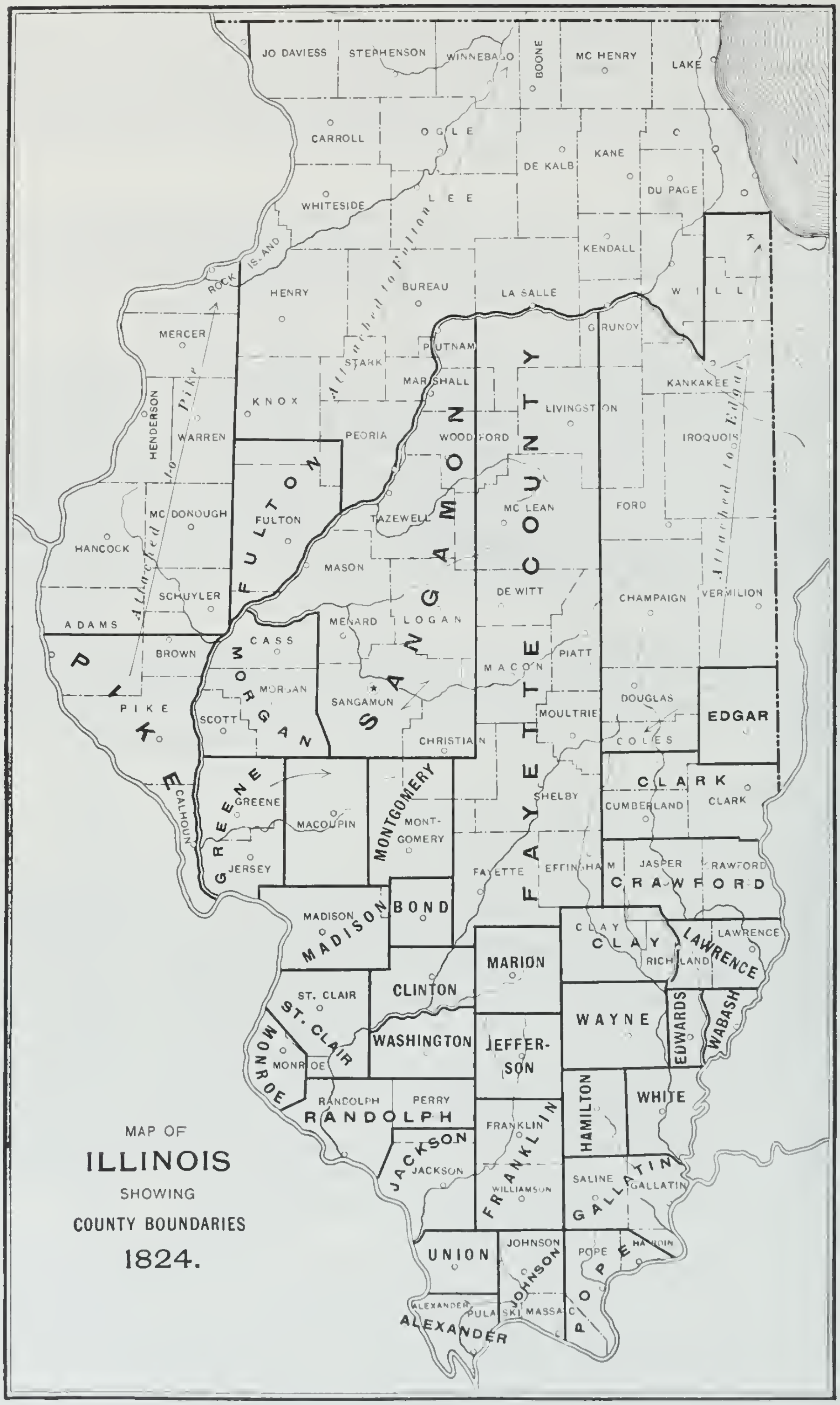


Figure 1 Illinois county boundaries as of 1823.

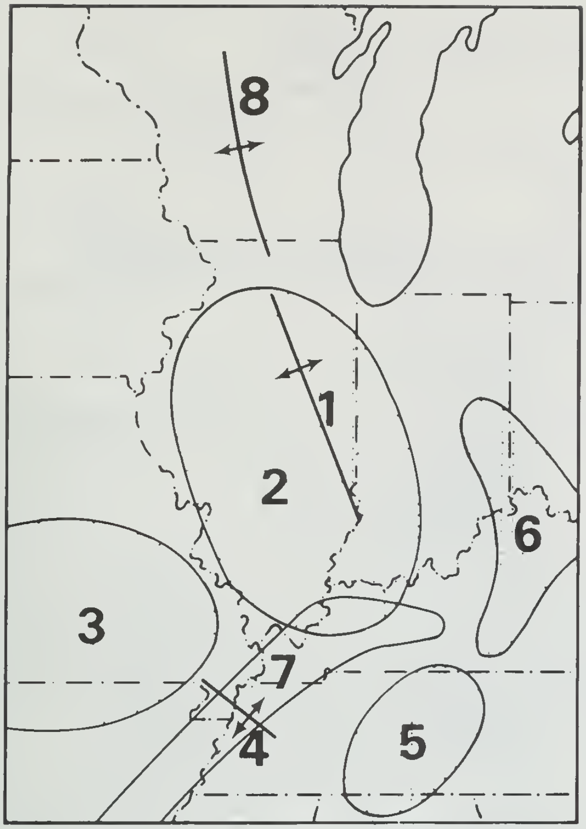


Figure 2 Location of some of the major structures in the Illinois region. (1) La Salle Anticlinal Belt, (2) Illinois Basin, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, (6) Cincinnati Arch, (7) Rough Creek Graben-Reelfoot Rift, and (8) Wisconsin Arch.

Because geologists seldom see Precambrian rocks except as cuttings from drill cores, they have determined some characteristics of the basement complex by using various indirect techniques, including measurements of Earth's gravitational and magnetic fields, and seismic tests. The evidence indicates that rift valleys similar to those in east Africa began to form in what is now southernmost Illinois during the late Precambrian *Era*. These midcontinent rift structures, known as the Rough Creek *Graben* and the Reelfoot Rift (fig. 2), formed when plate *tectonic* movements began to rip apart an ancient Precambrian supercontinent. The slow fragmentation of this Precambrian supercontinent eventually isolated a new landmass called *Laurasia*, which included much of what is now the North American continent.

Near the end of the Precambrian Era and continuing until late Cambrian time, from about 570 million to some 505 million years ago, tensional forces within the planet apparently caused block faulting (see *fault*) and relatively rapid subsidence of the hilly landscape on a regional scale. A broad trough formed extending northward from the continental margin in central Arkansas across Illinois, Indiana, and Kentucky. Into this trough or embayment, a shallow sea encroached from the south and southwest. This trough, which persisted for millions of years, has an area of about 135,000 square miles (Bell et al. 1964).

Paleozoic Era

During the Paleozoic Era, which lasted from about 570 million years ago to some 245 million years ago, the land that now lies under southern Illinois sank slowly while layer upon layer of sediment collected in the shallow seas that repeatedly covered it. Nearly 17,000 feet of sedimentary *strata* accumulated during the 325 million years of the Paleozoic Era. These sediments, when compacted and hardened (*lithified*), and the underlying Precambrian rocks became the *bedrock* succession.

SYSTEM	SERIES	GROUP	FORMATION	GRAPHIC COLUMN	THICKNESS (FEET)	LITHOLOGY
QUATERNARY	PLEISTOCENE				0-100+	Loess, till, sand, gravel, silt (details in figure 8)
TERTIARY	PLIOCENE				0-10	Gravel
PENNSYLVANIAN		McLeansboro			500	Shale, sandstone, clay, coal, limestone (details in figure 22 and table 3)
		Racoon Crk				
MISSISSIPPIAN	VALMEYERAN	Meramecan	St. Louis		0-150	Limestone, light, cherty
			Salem		0-46	Dolomite, sandstone, and sandy shale
		Osagian	Warsaw		0-75	Shale, dolomitic, with geodes
			Keokuk		0-140	Limestone, cherty
			Burlington		80-100	Limestone, cherty
	KINDERHOOKIAN		Hannibal		75-150	Shale, greenish and gray
	UPPER		Grassy Creek		110-160	Shale, brownish gray to black
DEVONIAN	MIDDLE		Cedar Valley		0-100	Limestone, crystalline, dolomitic, sandy
			Wapsipinicon		0-35	Limestone, dolomite
SILURIAN	NIAGARAN				0-210	Dolomite, light gray, cherty
	ALEXANDRIAN		Kankakee		0-45	Dolomite, light gray
			Edgewood		15-20	Dolomite, sandy, shaly
ORDOVICIAN	CINCINNATIAN	Maquoketa			70-90	Shale, dolomitic, brown
					6-30	Dolomite, brownish gray
					50-90	Shale, dolomitic, brown to black
	CHAMPLAINIAN	Galena			175-200	Dolomite, buff, crystalline, porous
					5-20	Dolomite, shaly
		Platteville			100	Dolomite, buff, fine-grained
		Ancell	Glenwood		60-100	Sandstone, shale and dolomite, glauconitic
			St. Peter		170-250	Sandstone, light buff, incoherent
	CANADIAN	PRAIRIE DU CHIEN	Shakopee		160	Dolomite, reddish, argillaceous
			New Richmond		70	Sandstone, dolomitic
			Oneota		353	Dolomite, with oolitic chert
			Gunter		36	Dolomite, sandy
CAMBRIAN	ST. CROIXAN		Eminence		100	Dolomite, light gray, with oolitic chert
			Potosi		210	Dolomite, brown to pinkish gray, glauconitic
			Franconia		131	Dolomite, sandy, glauconitic
			Galesville		137	Sandstone, light buff, incoherent
			Eau Claire		2' penetrated	Dolomite, sandy

Figure 3 Generalized columnar section of exposed strata and strata penetrated in wells (after Wanless 1957).

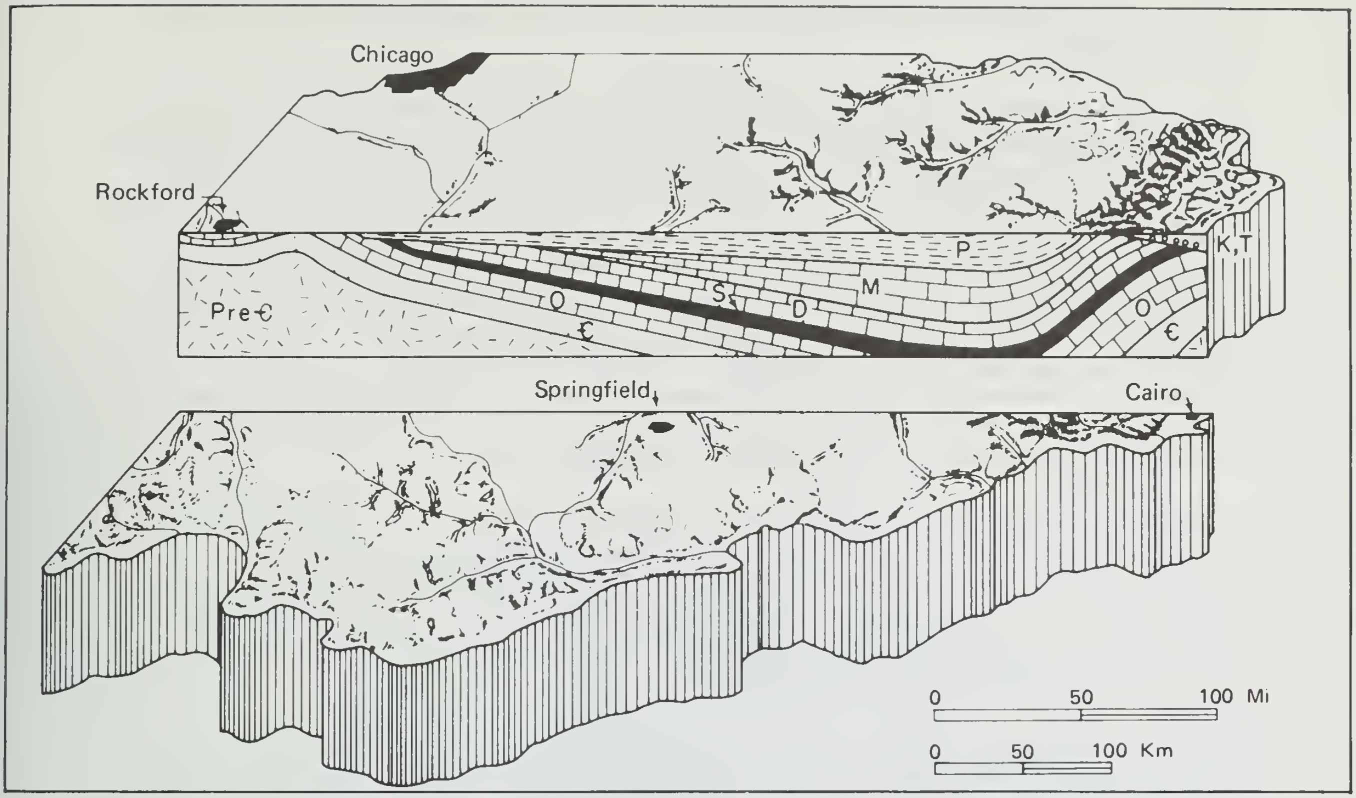


Figure 4 Stylized north-south cross section shows the structure of the Illinois Basin. In order to show detail, the thickness of the sedimentary rocks has been greatly exaggerated and the younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-C) granites. They form a depression that is filled with layers of sedimentary rocks of various ages: Cambrian (C), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). The scale is approximate.

From middle Ordovician time, about 460 million years ago, until the end of the Permian Period (and of the Paleozoic Era) some 245 million years ago, the area now known as the Illinois Basin (including most of Illinois, westernmost Indiana, and western Kentucky) sank more slowly than it had earlier. Repeatedly, sediments poured into the broad trough or embayment covering the area (noted previously) and overflowed into surrounding areas as well. Shells of marine animals, muds, silts, and sands deposited in those seas over millions of years were gradually buried and lithified into solid rocks of limestone, dolomite, shale, siltstone, and sandstone.

Earth's thin crust has frequently been flexed and warped in various places by forces of compression and tension that developed within the earth at various times. Movements of the land surface, flexing upward then downward, recurred over millions of years and caused the seas to periodically drain from the region, then slowly return. When the sea floors were uplifted and exposed to weathering and erosion by rain, wind, and streams, some previously deposited strata were eroded. Consequently, not all geologic intervals are represented in the rock record of Illinois (see generalized geologic column, page iv).

The geologic column Figure 3 shows the succession of rock strata that a drill bit would be likely to encounter in the Lewistown–Spoon River area; the oldest *formations* are at the bottom of the column. Figure 4 shows an interpretation of the general configuration and structure of sedimentary rock strata in Illinois. Sedimentary rocks in Illinois are classified by using formation names. Some formations contain thin, distinctive units called members. Because of great simi-

larities in appearance and composition, some formations are classified and mapped together in a unit called a *group.*

Many of the formations in groups have conformable contacts, which means that no significant interruptions took place between deposition of the sediments of one formation and the sediments of another (fig. 3). In some cases, the composition and appearance of the rocks change significantly at the contact between two formations, even though the fossils in the rocks and the relationships between the rocks indicate that deposition was essentially continuous; this type of contact is called a *disconformity.* In other cases, the lower formation was subjected to weathering that partly eroded it before sediments of the overlying formation were deposited. When this happens, fossils and other evidence in the formations indicate a significant gap between the time when the lower unit was deposited and the time when the overlying unit was laid down. This type of contact is called an *unconformity.* If the lower strata were tilted and eroded before the overlying strata were deposited, the contact is called an angular unconformity. (Unconformities are shown as undulating lines across the rock unit column in many geologic columns.)

Geologic framework of the field trip area As noted earlier, Fulton County is underlain by about 3,900 feet of Paleozoic *sedimentary* rocks in the northwest to some 4,400 feet in the east-southeast. These strata range in age from deeply buried rocks of the late Cambrian (about 523 million years old) to surface exposures of middle Pennsylvanian age (about 312 million years old). The oldest Paleozoic rocks exposed in the area are Mississippian in age and formed from sediments that accumulated some 350 million years ago.

This part of west-central Illinois is located on the Western Shelf of the Illinois Basin (Bell et al. 1964, J. Treworgy 1981), an area that lies between the Mississippi River Arch and the Fairfield Basin, the northernmost of the depressions that define the deepest parts of the Illinois Basin (figs. 4 and 5). The Precambrian surface slopes gently southeastward at less than 1° for nearly 200 miles, from an elevation of about –3,400 feet mean sea level (msl) in the northwestern part of the Lewistown–Spoon River area, to an elevation lower than –12,500 feet msl in central eastern Hamilton County.

Figure 6 shows where the major bedrock units in Illinois would be located if all the glacial deposits were scraped off. Bedrock exposures in the field trip area are limited essentially to outcrops along Spoon River, some of its tributary streams, highway and railroad cuts, and quarries. Generally, rocks of the Pennsylvanian *System* (figs. 3 and 6) occur at or just below the surface over most of the area, whereas strata of the Mississippian System are restricted to scattered exposures along Spoon River.

The depositional history of the region is linked with tectonic events. During Late Mississippian and Early Pennsylvanian time, the east coast of the present North American continent was colliding with another continent, thus creating the Appalachian Mountains. Several major structural features formed in the midcontinent region, including the La Salle Anticlinal Belt (see *anticline*) extending south-southeastward from La Salle County to around Lawrence County. In addition, minor wrinkling of the bedrock produced a number of small southwest-northeast trending anticlines and *synclines* in Fulton County and adjacent areas. The most notable in the field trip area is the rather broad Seville Anticline in which Mississippian St. Louis, Salem, and Warsaw Formations are exposed along the axis, surrounded by Pennsylvanian strata. Although this feature may be partly a topographic high on the pre-Pennsylvanian erosion surface, it also appears to be structurally high on the pre-Pennsylvanian strata.

Mesozoic and Cenozoic Eras

Although Paleozoic rocks are present everywhere in Illinois, there is not much evidence to indicate that younger sediments of the Mesozoic or Cenozoic Eras accumulated to any extent during

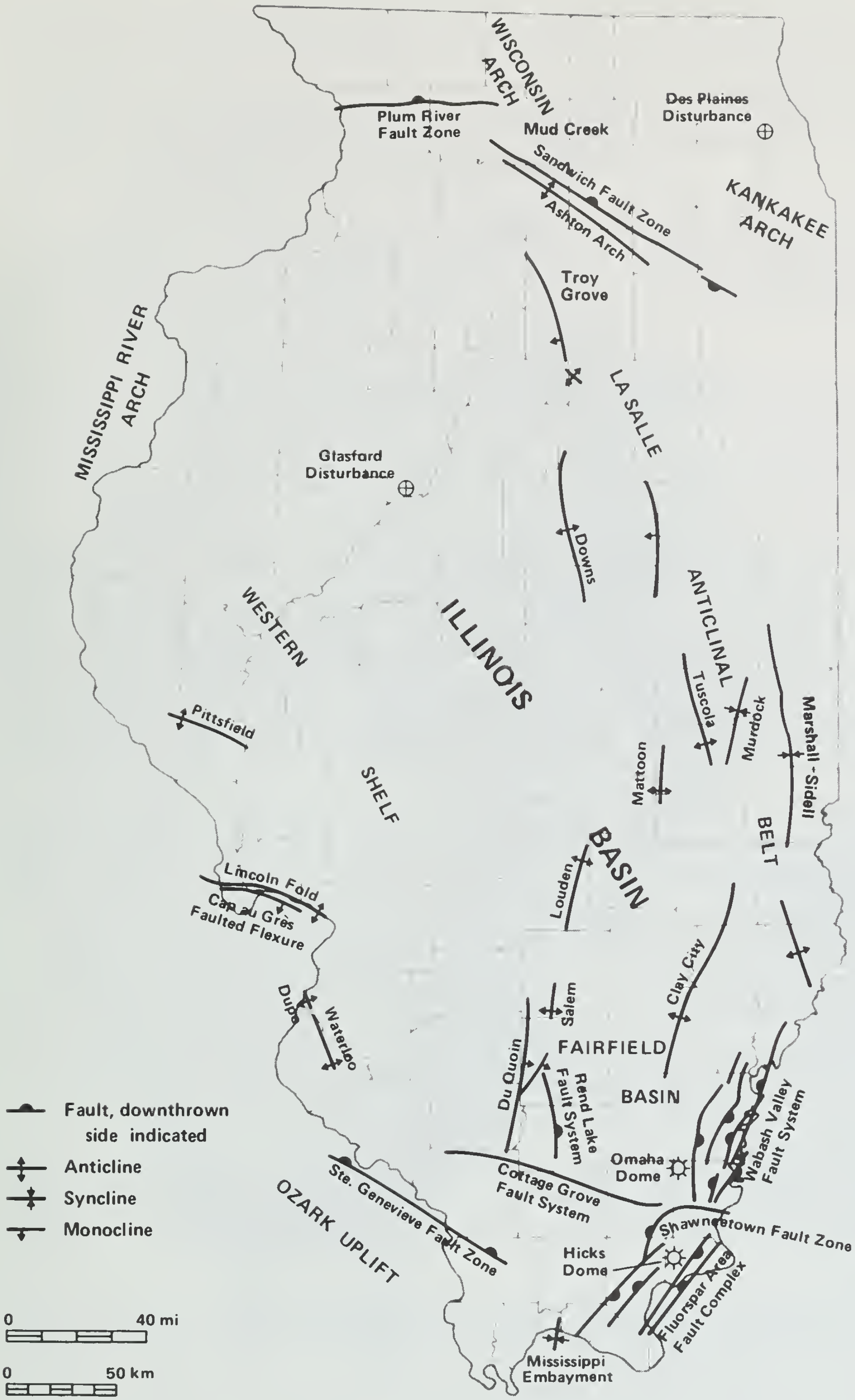


Figure 5 Structural features of Illinois.

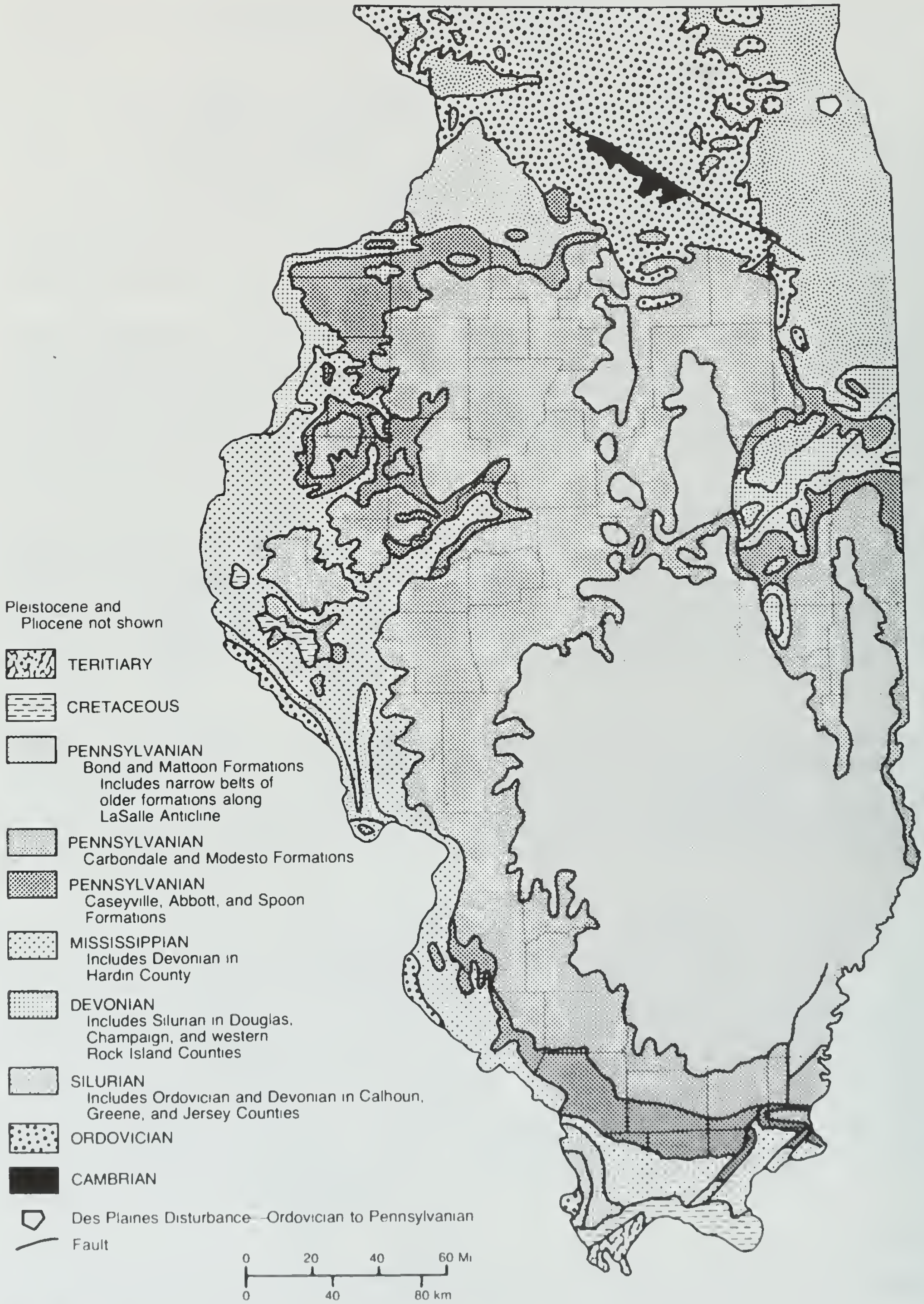


Figure 6 Bedrock geology beneath surficial deposits in Illinois.

the long interval between deposition of the latest Pennsylvanian rocks and deposition of the Pleistocene glacial *drift*. This "sub-Pleistocene unconformity," the bedrock surface in Illinois, truncates all Tertiary, Cretaceous, and Paleozoic rocks down to the Upper Cambrian rocks exposed at the bedrock surface in the Sandwich Fault Zone of northern Illinois. Mesozoic rocks are absent from the stratigraphic record in almost all parts of the state, except for extreme southern Illinois and scattered deposits in Adams and Pike Counties about 55 miles to the southwest. Cenozoic materials (the glacial drift and related deposits) cover most of the state.

In the Lewistown–Spoon River area, small, thin, scattered outcrops of gravel of Pliocene age (?) and glacial materials are the only deposits younger than those of Pennsylvanian age, which are some 300 million years old. The tectonic history (the history of Earth's crustal movements) of the region during the past 570 million years is only partly known and the rest must be inferred from evidence present in other places.

During the Mesozoic and Cenozoic Eras, but before the onslaught of glaciation 1 to 2 million years ago, the land surface of Illinois was exposed to weathering and erosion. Deep valley systems were carved into the gently tilted bedrock formations. This rugged *topography* then was considerably subdued by glaciers that scoured and scraped the old erosion surface as they repeatedly advanced and retreated. All except the Precambrian rocks were exposed to erosion.

Quaternary geology About 1.6 million years ago, during the Pleistocene *Epoch* (commonly called the Ice Age), continental glaciers flowed slowly southward from the northern to the midlatitudes (see appendix, *Pleistocene Glaciations in Illinois*). Several times, ice sheets covered parts of the region we know as Illinois. The last of these glaciers melted from the northeastern area of the state about 13,500 years before the present (B.P.), near the close of Wisconsinan time. Continental glaciers reached their southernmost extent in North America during the Illinoian glaciation about 270,000 years B.P. Evidence of the southern limit of glaciation can be observed in northern Johnson County, about 210 miles southeast of Lewistown (fig. 7). A generalized section illustrating types of Pleistocene deposits is found in figure 8.

Until recently, glaciologists assumed that ice thicknesses of 1 mile or more were likely for these glaciers; however, the ice may have been, at most, about 2,000 feet thick in the Lake Michigan Basin and on the order of 700 feet thick across most of the land surface. This conclusion is based on the following lines of evidence:

1. inferences about the geometry, configuration and rates of flow of the ancient ice masses developed from data on the strength and other characteristics of present-day ice sheets and ice caps, such as those in Greenland and Antarctica;
2. estimates of the thickness of ice masses based on the heights of moraines and the flow directions of the ice; and
3. observations about the degree of compaction and consolidation of the drift materials that must have been under the continental glaciers and thus give indications about the weight (and by inference, the thickness) of ice necessary to cause the compaction.

Finally, some workers have suggested that the small amount of rebound that apparently has occurred in the Lake Michigan basin area can only be explained if the ice mass did not exceed about 2,000 feet in thickness. The exact amount of rebound of the region, however, remains controversial.

The ice of various glaciations was active and thick enough to scour and remove part of the bedrock surface. Much of the evidence for pre-Illinoian and early Illinoian glaciations is missing from the northern part of our state; it was removed by the effects of the subsequent Wisconsinan glaciation. Studies in western Illinois currently underway are demonstrating that pre-Illinoian sediments can be traced in the subsurface from the Mississippi River to the Illinois River Valley in Ful-

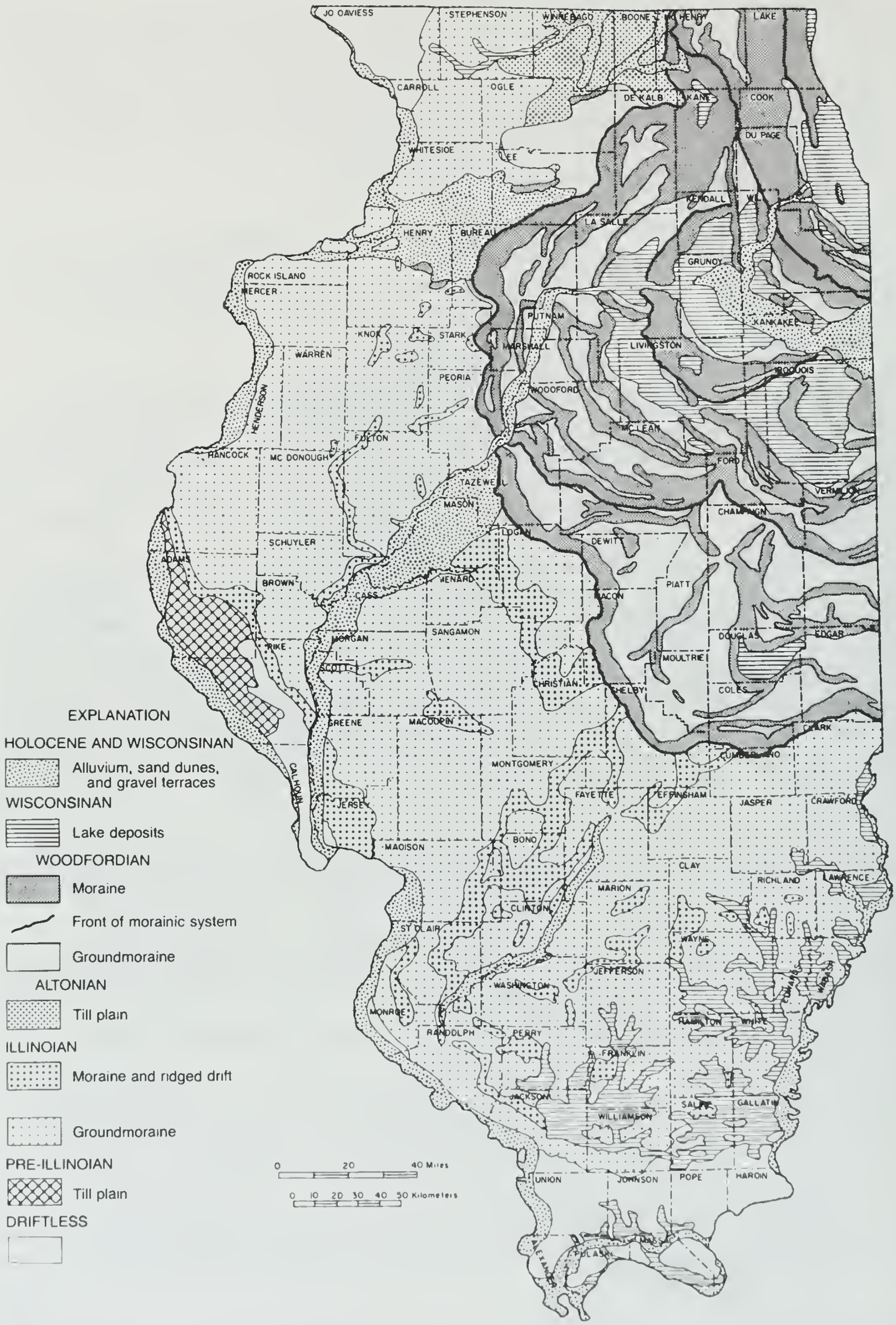


Figure 7 Generalized map of glacial deposits in Illinois (modified from Willman and Frye 1970).

STAGE	SUBSTAGE	UNIT	COLUMN	MAXIMUM THICKNESS	LITHOLOGY	
RECENT				(feet) 45	Stream alluvium, fans, colluvium, dune sand	Sand dunes
WISCONSINAN		Peoria Loess - 50'		80	Sand, pebby sand, terrace deposits	
				10	Loess, gray, buff	
				20	Silt, laminated; sand	
				9	Clay, red	
				100 120 20	Sand, gravel	
				15	Loess, gray, buff	
		Roxana Silt		18	Loess, brown	
SANGAMONIAN					Weathered zone	
ILLINOIAN	JUBLEEAN	Glasford Formation: Radnor Till Mbr		30	Till	
				10	Silt, varved	
	MONICAN			45	Sand, gravel	
		Hulick Till Mbr		45	Till, gravel	
	LIMAN	Kellerville Till Mbr		50	Till	
	LOVELAND			15	Loess	
YARMOUTHIAN					Weathered zone	
				10	Gravel and silt	
PRE-ILLINOIAN-PRE-PLEISTOCENE				15	Sand, gravel	
				8	Silt, fossiliferous	
				32	Till	
				5	Loess	
				2	Silt, laminated	
					Weathered zone	
				5	Silt, leached	
				12	Gravel	
				6	Till, sand	
				10	Silt, sandy, locally cobbly at base	

Figure 8 Generalized columnar section of Pleistocene deposits (after Wanless 1957)

ton County. A recently constructed cross section across Hancock, McDonough, and Fulton Counties suggests that pre-Illinoian sediments may be present directly beneath the loess in a broader area of western Illinois than previously supposed (Killey, 1993, unpublished data). This preliminary finding must be confirmed by additional sample studies and x-ray diffraction analyses of the clay minerals in these sediments, as well as by additional cross sections based on these studies.

In the field trip area, the glacial deposit immediately beneath the loess is the Illinoian Hulick Till Member of the Glasford Formation. The matrix of this *diamicton* averages 26% sand, 45% silt, and 29% clay (Lineback 1979a) in western Illinois. Recent x-ray diffraction analyses of the clay fraction of the till in the field trip area reveal a typical Hulick clay mineral composition of 12% expandable clay minerals, 59% illite, and 29% kaolinite plus chlorite (H. D. Glass, 1993, personal communication). This rather high percentage of kaolinite reflects the influence of the Pennsylvanian shales underlying much of the field trip area.

The Woodfordian Substage of the Wisconsinan Stage (fig. 8), the last major glacial advance, began about 25,000 to 22,000 years B.P. Ice from an accumulation center where Labrador now lies slowly flowed southward through the Lake Michigan Basin to form the Lake Michigan Glacial Lobe that spread out across what is now northern Illinois.

In the field trip area, the materials deposited by the glaciers (glacial drift) are generally less than 25 feet thick under the upland where numerous bedrock exposures can be found in small stream and road cuts, unless covered by slumped surface materials. Glacial deposits exceed 100 feet in thickness in the Illinois and Spoon River drainageways and in the lower parts of their major tributaries.

The landscape in the Lewistown–Spoon River area developed on bedrock covered by the relatively thin Illinoian drift. Both bedrock and the glacial drift were eroded during and after glaciation. The closest that younger Wisconsinan glaciers of the Woodfordian Substage came to this field trip area was 7 miles south of Pekin, about 30 miles east-northeast of Lewistown. Outwash materials from the waning ice front, however, were transported through this area by meltwater torrents rushing toward the sea. Each summer, floods of sediment-laden meltwater deposited layers of mud, silt, sand, and gravel across the floodplains of the rivers. With the coming of winter, melting decreased and floodplains that were water-covered during the summer were exposed to harsh, bitter, drying winds. The cold winds winnowed out and picked up huge clouds of dust, silt, and sand from the floodplains and spread the material across the land. Windblown fine sand and some of the coarser silt were deposited along the valley walls of the outwash streams; finer material called *loess* was carried across the uplands where it was deposited as a blanket that becomes thinner eastward away from the streams. The Mississippi and Illinois Rivers were the major sources of this loess, but other floodplains were local sources. Loess deposits, which are about 15 feet thick across the upland near Lewistown, thicken slightly southeast toward the Illinois River Valley, but thin to less than 10 feet thick some 8 miles to the northwest. The loess helped to subdue features developed on the eroded glacial surface. Loess deposits were being eroded during and after the Woodfordian glaciation that reached its maximum western and southern extent about 21,000 years B.P.

GEOMORPHOLOGY

Physiography

The physiographic contrasts between various parts of Illinois exist because of several factors, including the topography of the bedrock surface, differences in the hardness and resistance to erosion of various earth materials, the extent of the various glaciations, differences in the thickness of the glacial deposits, differences in the age of the uppermost glacial drift, and the effects of erosion on the land surface.

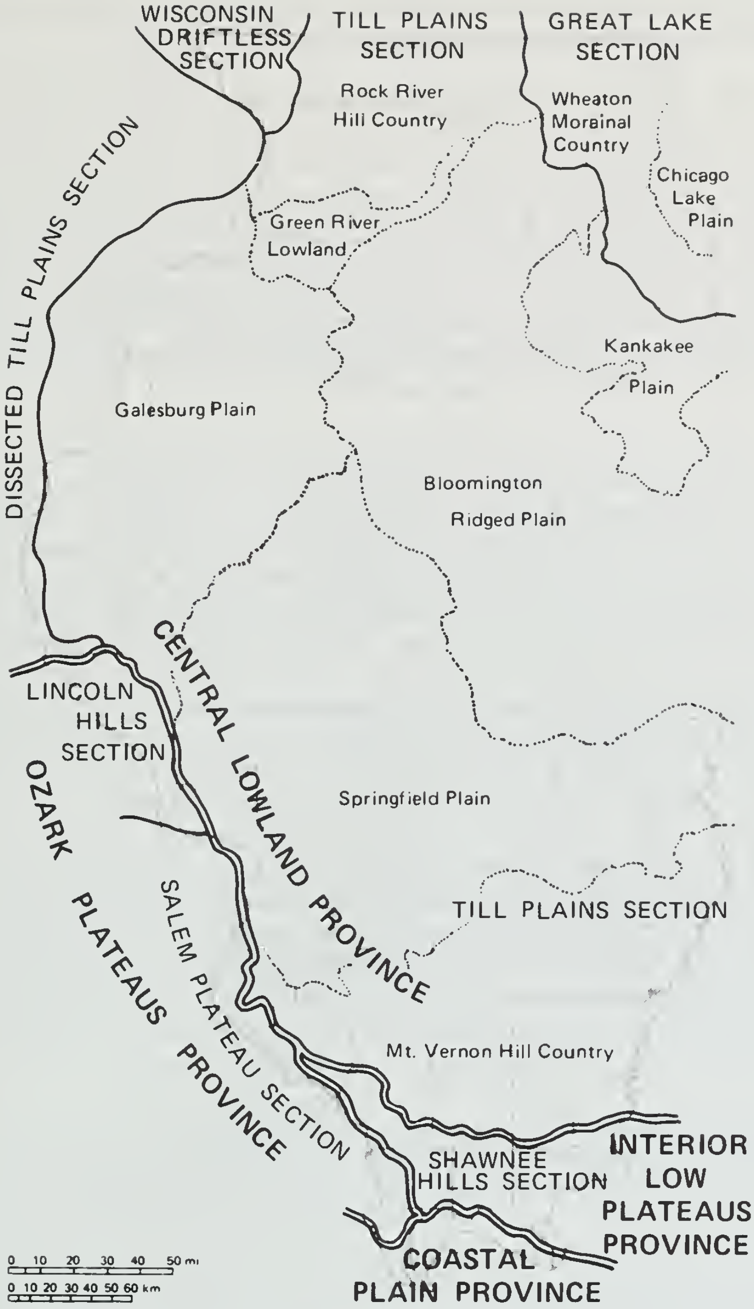


Figure 9 Physiographic divisions of Illinois.

The Lewistown-Spoon River field trip area lies in the southeastern part of the Galesburg Plain, the westernmost part of the Till Plains Section, the division of the Central Lowland Physiographic Province (fig. 9) that embraces about four-fifths of Illinois.

The Till Plains Section is characterized by broad *till* plains that are relatively uneroded (a youthful stage of erosion), in contrast to the maturely eroded Dissected Till Plains on older drift sheets in Iowa. In Illinois, the Till Plains Section has seven subdivisions: the Bloomington Ridged Plain,

Galesburg Plain, Green River Lowland, Kankakee Plain, Mt. Vernon Hill Country, Rock River Hill Country, and the Springfield Plain.

The Galesburg Plain, according to Leighton et al. (1948), includes the western segment of the Illinoian drift sheet, a level to undulatory plain with a few morainic ridges that was formed some 250,000 years ago. It is in late youth in the erosion cycle; i.e., the fairly extensive reaches of flat to gently undulating uplands, some of which are relatively uneroded, have been dissected by hundreds of tributary streams so that about half the area is now in slopes. Streams occupy narrow, V-shaped valleys that show little valley-flat or floodplain development. This contrasts markedly with the younger Wisconsinan surfaces to the northeast, and the more highly dissected plains of pre-Illinoian drift in Missouri and Iowa. The former are much younger and have not been eroded as much; fewer streams have dissected the area much less and fairly extensive upland tracts remain. The latter plains generally are maturely eroded and have only limited areas remaining in uplands.

According to Horberg (1946) and Leighton et al. (1948), prior to glaciation, an extensive lowland called the "central Illinois peneplain" had been eroded into the relatively weak rocks of Pennsylvanian age east and south of the present-day Illinois River. The surface appears to have been one of low relief and it sloped gently southward. Just before the advent of glaciation, an extensive system of bedrock valleys was deeply entrenched below the level of the central lowland surface. The gross features of the Till Plains Section, as well as local features of the Galesburg Plain, are determined largely by this preglacial topography. As glaciation began, streams probably changed from erosion to aggradation, that is, the streams began to deposit sediments and fill in their channels because they did not have sufficient volumes of water to carry and move the increased quantities of sediment coming from the advancing glaciers. Available evidence indicates that valley-fill materials were only partially removed by various pre-Illinoian interglacial stages.

Pre-Illinoian glacial deposits are sporadic in their occurrence across Illinois and their areal extent is not well known, mainly because the early deposits were severely eroded by subsequent glaciations. Younger glacial deposits conceal the pre-Illinoian material except in western Illinois where the older glacial debris is exposed in some valley walls beneath the outer edge of the sheet of Illinoian drift (see Glacial Map of Illinois in *Pleistocene Glaciations In Illinois* in appendix). Wanless (1957) reported finding pre-Illinoian glacial deposits just to the east of the field trip area.

Drainage

In this field trip area, drainage is to the south and east to the Illinois River via Spoon River and its tributaries. Major tributaries to the Spoon from the east include Big, Put, Muddy, Lost Grove, and Turkey Creeks; major tributaries from the west include Tater, Francis, Badger, Barker, Shaw, and Shoal Creeks. Most streams in the modern drainage system of the field trip area have low *gradients* (bottom slopes) and are actively widening their bottomlands. The uplands generally have fairly good natural drainage, with the possible exception of small tracts in scattered upland prairies. Because the Illinoian drift and Wisconsinan loess are relatively thin throughout much of the area, the modern course of Spoon River generally follows closely the alluviated preglacial lower Spoon bedrock valley in the area.

Relief

The highest land surface elevation along the Lewistown-Spoon River field trip route is some 2 miles west and north from the Hull School site, south-southwest of Smithfield, where a benchmark at the T-intersection shows 672 feet msl. The lowest elevation is less than 440 feet msl, the water surface of Spoon River below the bridge at Duncan Mills (Stop 1). The maximum relief along the field trip route, calculated as the difference between the highest and lowest surface elevations, therefore, is more than 230 feet within a horizontal distance of about 11¼ miles. The maximum local relief is slightly more than 150 feet from the ridge top above Bernadotte at

Stop 4 to the dam across Spoon River 0.15+ mile away. Bluffs along the Spoon, the most prominent surface feature in the area, are generally more than 100 feet high.

MINERAL RESOURCES

Groundwater

A mineral resource frequently overlooked in assessing an area's natural resource potential is *groundwater*. Its availability can be essential for orderly economic and community development. Groundwater is the water supply for more than 5 million people who live in 88% of the state. The other half of the population, mainly people living in Chicago, rely on surface water supplies mainly from Lake Michigan. Because of their importance to so many people, studies of groundwater resources are an integral part of the research and service programs at the Illinois State Geological Survey (ISGS).

Groundwater resources are obtained from underground formations called aquifers. *Aquifer* materials (sand and gravel, sandstones, fractured rocks) are water-saturated and permeable enough to transmit usable quantities of water to wells or springs. The source of groundwater is precipitation—rainwater or melting snow—that enters and infiltrates through the soil. Soil moisture that is not evaporated or used by plants percolates or seeps downward (because of gravity) and replenishes the groundwater supply; this is called recharge. Recharge for most shallow wells occurs within a few miles of the well.

The water-yielding capacity of an aquifer is evaluated by constructing wells into it. Test wells are pumped and water samples collected to determine the quality and quantity of the water supply.

Sources of public water supplies in Fulton County are among the most diverse in the state. Water supplies for domestic and municipal use occur at the surface in rivers, lakes, and ponds, and in subsurface sand and gravel, sandstone and carbonate rocks within the Quaternary, Pennsylvanian, and Mississippian Systems of rocks. Bergstrom (1956) noted that most domestic wells are drilled into Pennsylvanian sandstones that occur a few feet below coal beds 50 to 300 feet deep, or into the creviced Mississippian Keokuk–Burlington limestones, 250 to 500 feet deep. Deeper bedrock strata are permeable and water-yielding, but the water is of poor quality. Upland sand and gravel deposits are thin and discontinuous and generally will only yield enough water for a single domestic water supply. Because the unconsolidated materials overlying bedrock are recharged by local precipitation, they are susceptible to surface contamination. The only filtering effect on recharge water is through clay layers present in the overlying glacial deposits, which may be thin. Relatively thick sand and gravel deposits that may be capable of yielding adequate volumes of good quality groundwater for municipal supplies are present in the Illinois and Spoon Valleys.

Lewistown, population about 2,700, draws its water from seven wells that range from 33 to 47 feet deep in the Spoon River lowlands, some 2 miles southwest of the water tower. These wells pump about 1.0 million gallons per day (mgd).

Slightly more than 2 miles northwest of Lewistown High School, an unused flowing well is located at Depler Springs in Epworth Campground. The well is reported to be 2,243 feet deep. In 1918, it flowed at a rate of 1,500 gallons per minute (gpm); but in 1975 it only yielded about 2 gpm. This well was located in an aeration pool from which water flowed through two swimming pools before emptying into Big Creek. The water contained considerable sulfur, which gave it a rotten egg odor; hence the need for the aeration pool. People came from miles around to fill jugs from the large tile well-head. Anything that odoriferous just had to be good medicine for one's aches and pains.

The ISGS first engaged in geophysical field studies in the search for adequate municipal ground water supplies in Fulton County at Vermont in 1936. Subsequently, studies were conducted at the following locations in the county: Farmington 1945, Fairview and Table Grove 1950, Lewistown 1957, Banner 1974, Avon 1981, St. David–Dunfermline Water district 1983, and the Fulton County Water District 1991.

Mineral Production

Of the 102 counties in Illinois, 98 reported mineral production during 1990, the last year for which totals are available. The total value of all minerals extracted, processed, and manufactured in Illinois was $2.9 billion (Samson 1992).

In 1990, Illinois ranked fifth in the nation in coal production; 61.7 million tons were mined and valued at $1,709.8 million. The nearly 20 million barrels of crude oil produced in 1990 were valued at $406.5 million, ranking the state 13th among the oil-producing states. Less than 0.7 million cubic feet of natural gas, valued at nearly $1.5 million, were produced in the state during 1990. In 1989, the latest year for which data are available, total Illinois stone production was estimated at 62.7 million tons, valued at $283.1 million; reported tonnage placed Illinois fourth among 48 states reporting production of crushed and broken stone. In the 54 Illinois counties that produced stone, 103 companies operated 178 quarries. Stone is used primarily for construction aggregate, especially as road-base stone, but it is also used in chemical and agricultural production. Illinois ranked seventh in the production of sand and gravel during 1990, with a total extraction of 32.4 million tons, valued at $104.7 million at the pit. In 1990, 107 companies operated 157 sand and gravel pits at 143 operations in 55 counties.

Fulton County ranked 40th among Illinois counties reporting mineral production during 1990. Coal, stone, and sand and gravel were extracted. The dollar value of these minerals is confidential information.

GUIDE TO THE ROUTE

Assemble in the parking area on the southwest side of Lewistown High School at the north edge of Lewistown on the east side of State Routes (SR) 97 and 100 (W½ SE SE SW Sec. 15, T5N, R3E, 4th Principal Meridian [P.M.], Fulton County; Lewistown 7.5-Minute Quadrangle [40090D2]*).

You must travel in the caravan. ***Do not drive ahead of the caravan!*** Please keep your headlights on while in the caravan. Drive safely but stay as close as you can to the car in front of you. Please obey all traffic signs. If the road crossing is protected by a guard vehicle with flashing lights and flags, then obey the signals of the ISGS staff member directing traffic. When we stop, park as close as possible to the car in front of you and turn off your lights.

Some stops on the field trip are on private property. The owners have graciously given us permission to visit on the day of the field trip only. Please conduct yourselves as guests and obey all instructions from the trip leaders. So that we may be welcome to return on future field trips, please do not litter or climb on fences. Leave all gates as you found them. These simple rules of courtesy also apply to public property. If you use this booklet for a field trip with your students, youth group, or family, you must (because of trespass laws and liability constraints) get permission from property owners or their agents before entering private property.

Miles to next point	Miles from start	
0.0	0.0	EXIT from the parking lot via the north driveway in front of Lewistown High School. STOP: 1-way at SRs 97 and 100. NOTE: mileage calculations begin at this intersection. TURN LEFT (south) on North Main Street.
0.55	0.55	To the right is Oak Hill Cemetery. Two columns erected here are from the third Fulton County courthouse, destroyed by fire in December 1894. On August 17, 1858, Abraham Lincoln mounted a platform put up between these columns and spoke to 6,000 people crowded into the Lewistown public square. He opened and closed by calling on the principles set forth in the Declaration of Independence.

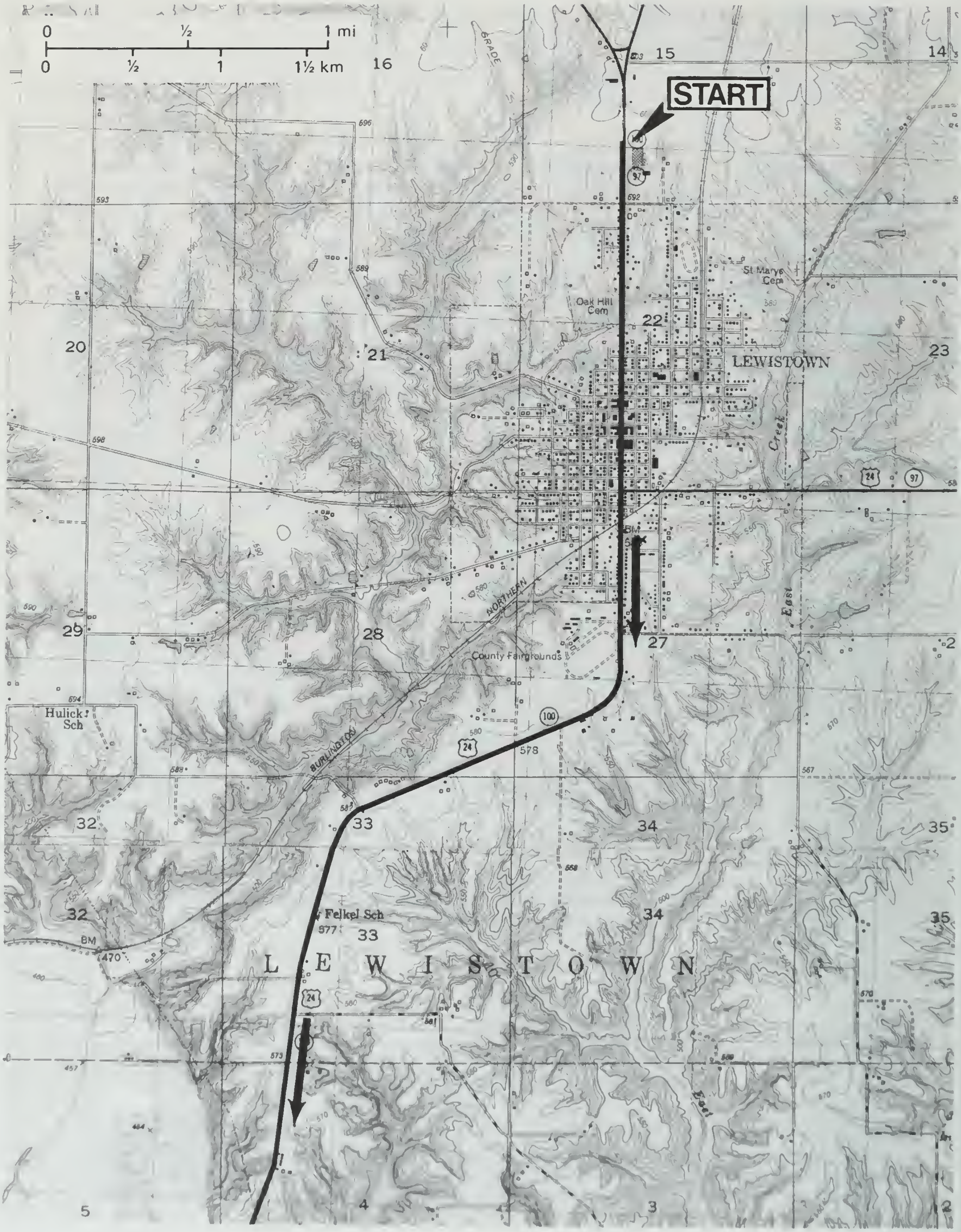
Lewistown was home to the young poet Edgar Lee Masters. Through the use of pseudonyms, epitaphs on tombstones and old tales became the inspiration and subjects for many of his poems in the *Spoon River Anthology*. The following passages are excerpted from "The Hill":

Where are Elmer, Herman, Bert, Tom and Charley,
The weak of will, the strong of arm, the clown, the boozer, the fighter?
All, all are sleeping on the hill.

One passed in a fever,
One was burned in a mine,
One was killed in a brawl,
One died in a jail,
One fell from a bridge toiling for children and wife—
All, all are sleeping, sleeping, sleeping on the hill.

---

*The number in brackets [40090D2] after the topographic map name is the code assigned to that map as part of the National Mapping Program. The state is divided into 1° blocks of latitude and longitude. The first two numbers refer to the latitude of the southeast corner of the block; the next three numbers designate the longitude. The blocks are divided into sixty-four 7.5-minute quadrangles; the letter refers to the east-west row from the bottom and the last digit refers to the north-south column from the right.


0
½
1 mi
0
½
1
1½ km
START
LEWISTOWN
Oak Hill Cem
St Marys Cem
County Fairgrounds
Hulick Sch
Felkel Sch
BURLINGTON
NORTHERN
East Creek
L E W I S T O W N
15
16
14
20
21
22
23
29
28
27
32
33
34
35
5
4
3
2

(stanzas omitted)

Where are Uncle Isaac and Aunt Emily,
And old Towny Kincaid and Sevigne Houghton,
And Major Walker who had talked
With venerable men of the revolution? -
All, all are sleeping on the hill.

They brought them dead sons from the war,
And daughters whom life had crushed,
And their children fatherless, crying -
All, all are sleeping, sleeping, sleeping on the hill.

Where is Old Fiddler Jones
Who played with life all his ninety years,
Braving the sleet with bared breast,
Drinking, rioting, thinking neither of wife nor kin,
Nor gold, nor love, nor heaven?
Lo! he babbles of the fish-frys of long ago,
Of the horse-races of long ago at Clary's Grove,
Of what Abe Lincoln said
One time in Springfield.

0.3+	0.85	CAUTION: entering Lewistown business district.
0.1	0.95	To the right is the fourth Fulton County courthouse. The first courthouse was made of logs in 1823. Because Fulton County embraced such a large area at that time (fig. 1), court cases, marriage and other licenses, voting, and other legal transactions for the whole area were carried out here. Chicagoans had to come to Lewistown for their marriage licenses. This location is also the start of the Lewistown Trail that extended northward to the lead mines near Galena in northwestern Illinois.
0.25	1.2	CAUTION: TRAFFIC LIGHT at junction with US 24. CONTINUE AHEAD (south) on Main Street (US 24 West and SR 100 South).
0.1	1.3	CAUTION: Guarded, single-track Burlington Northern (BN) railroad crossing.
0.4	1.7	Fulton County Fairground entrance to the right. The T-road intersecting to the left leads to Dickson Mounds Museum of the Illinois Indians. CONTINUE AHEAD (south and west) leaving Lewistown.
2.5	4.2	Begin descent from the relatively flat upland surface into the Spoon River Valley.
0.35	4.55	We are crossing a terrace level before descending into the Spoon River valley bottom. Here, the terrace extends along the north wall of the valley at an elevation of approximately 500 feet above mean sea level (msl).
1.0+	5.5+	Cross Spoon River and prepare to turn right.
0.05-	5.6+	TURN RIGHT (west) and PARK at Helms Park, Duncan Mills. Duncan Mills is named for mills built here in the 1830s. The hamlet was platted in 1867. The mill was torched in 1870 and was rebuilt, but it operated only a few more years.

CAUTION: walk back to the highway. Visibility is limited from the right (south). BE ALERT as we cross the bridge SINGLE FILE on the left side facing traffic and THEN cross the highway. Do NOT walk on the inside of the solid white line!

STOP 1 Pennsylvanian strata of the Lower Tradewater (formerly Abbott) Formation are exposed in the south bank of Spoon River on both sides of the highway (N½ NW NW SE Sec. 8, T4N, R3E, 4th P. M., Fulton County; Duncan Mills 7.5-Minute Quadrangle [40090C2]). NOTE: the south bank of Spoon River here can be very dangerous from loose rock, especially when the shales are wet and slippery.

This stop (see cover photo) begins our examination of the Tradewater Formation (formerly the Abbott and Spoon Formations) that will continue at Stops 2, 7, and 8. Please make a good mental note of what you see here so that you can compare it with exposures to be seen later. This will help to demonstrate the variability in lithologies found in the lower Tradewater strata. (Of course, a geologist working in the field, wouldn't just make a "mental note" of the appearance of the outcrop. He/she would prepare a detailed written description, including careful measurements of the thickness of the various lithologic units.)

The lower Tradewater exposed here (fig. 10) (formerly the Abbott Formation) best illustrates the finer clastic rocks (i.e., shales and siltstones) in the unit. At Stop 8 we will have a better opportunity to see the coarse clastics in this interval.

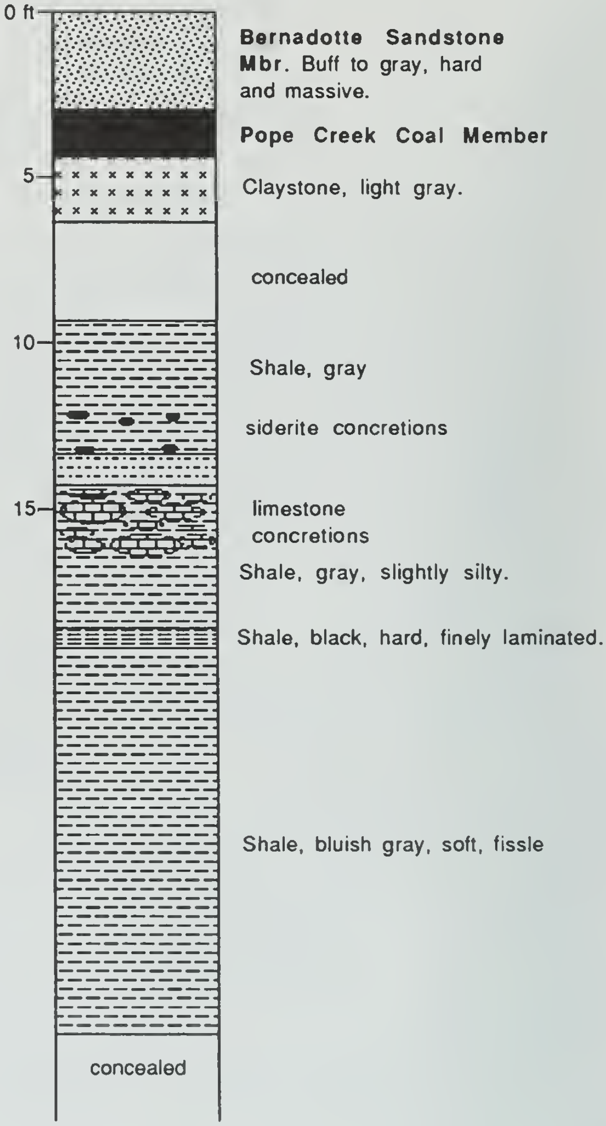
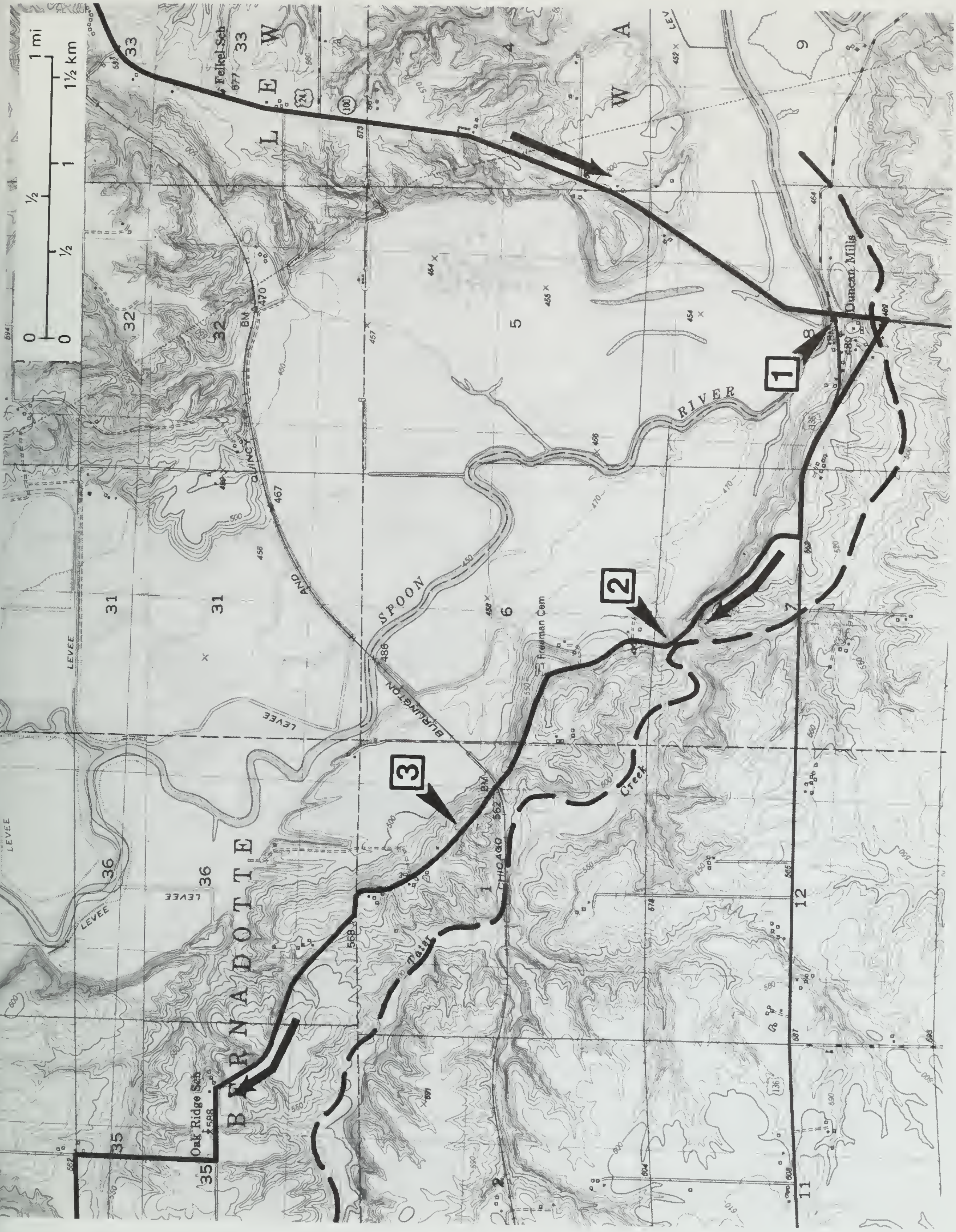


Figure 10 Stratigraphic column of the Lower Tradewater Formation (formerly Abbott) exposed at Stop 1 (after Wanless 1957, geologic section 26).

The Bernadotte Sandstone crops out near the top of the exposed bank, just below the overhanging grass and other vegetation. It continues up into the hills to the south; at one time it was exposed in the roadcut to the south. The Pope Creek Coal can be seen just below the sandstone. The zone of limestone concretions is resistant and stands out in the shale unit, as does the black shale below it. Both of these units are near the water line at the east edge of the bridge; they are covered when the Spoon River is high.

Return to your car by walking SINGLE FILE on the left (east) side of the bridge facing northbound traffic. Do NOT walk on the inside of the solid white line! Cross the highway to your car only when *all is clear from both directions.*


0
½
1 mi
0
½
1
1½ km
1
2
3
SPOON
RIVER
Duncan Mills
Oak Ridge Sch
Felkel Sch
Freeman Cem
CHICAGO
BURLINGTON
AND
QUINCY
LEVEE
Creek
B E R N A D O T T E
L E W
W A

0.0	5.65	Leave Stop 1 and return to US 24.
0.05-	5.7-	STOP: 2-way. TURN RIGHT (south) on US 24 and SR 100 and prepare to turn right.
0.15+	5.8+	TURN RIGHT (northwest) on US 136 at T-intersection.
0.05+	5.9	VIEW to left (west) at 10:30 o'clock of a glacial sluiceway; the former, higher position of Tater Creek.
0.4+	6.3+	VIEW of Spoon River Valley from scenic Duncan's Point on the right.
0.2	6.5+	Prepare to turn right.
0.15	6.65+	TURN RIGHT (north) on gravel road at T-intersection.
0.25	6.9+	Descend into Tater Creek Valley.
0.1+	7.05	CAUTION: washout along roadside; improper refuse disposal along right-of-way.
0.1	7.15	Weathered coal exposure to the left in the ditch; nearby slumping across the ditch.
0.1	7.25	PARK along road south of but NOT on Tater Creek Bridge. *Do NOT cross fences.*

STOP 2 Pennsylvanian strata of the Tradewater Formation (formerly Abbott and overlying Spoon Formations) are exposed along the north side of Tater Creek, in the roadcut to the north, and in adjacent outcrops. We'll discuss the reasons for slumped earth materials on the hillside to the south and view an example of stream piracy (N½ extended NE NW Sec. 7, T4N, R3E, 4th P. M., Fulton County; Duncan Mills 7.5-Minute Quadrangle [40090C2]).

In the creek bank and hill northeast of the bridge (fig. 11), we are seeing essentially the same interval of strata we saw downstream at Stop 1. While the exposure is not as clean and impressive here, shale obviously still is the main component. As a result, the rocks are poorly exposed and slumped. In this vicinity, up to three coals may be seen, from the Rock Island Coal (just above the Bernadotte Sandstone) to the underlying Tarter Coal. A coal presumably equivalent to the Pope Creek can be seen at Stop 8.

Slump scars are visible on the north-facing slope to the south. During times of heavy

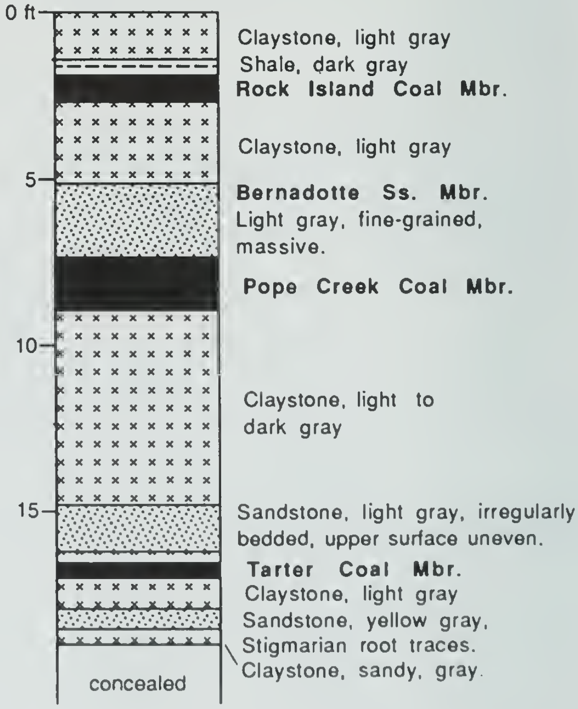


Figure 11 Stratigraphic column of the Tradewater Formation (formerly Spoon and Abbott) exposed at Stop 2 (after Wanless 1957, geologic section 26).

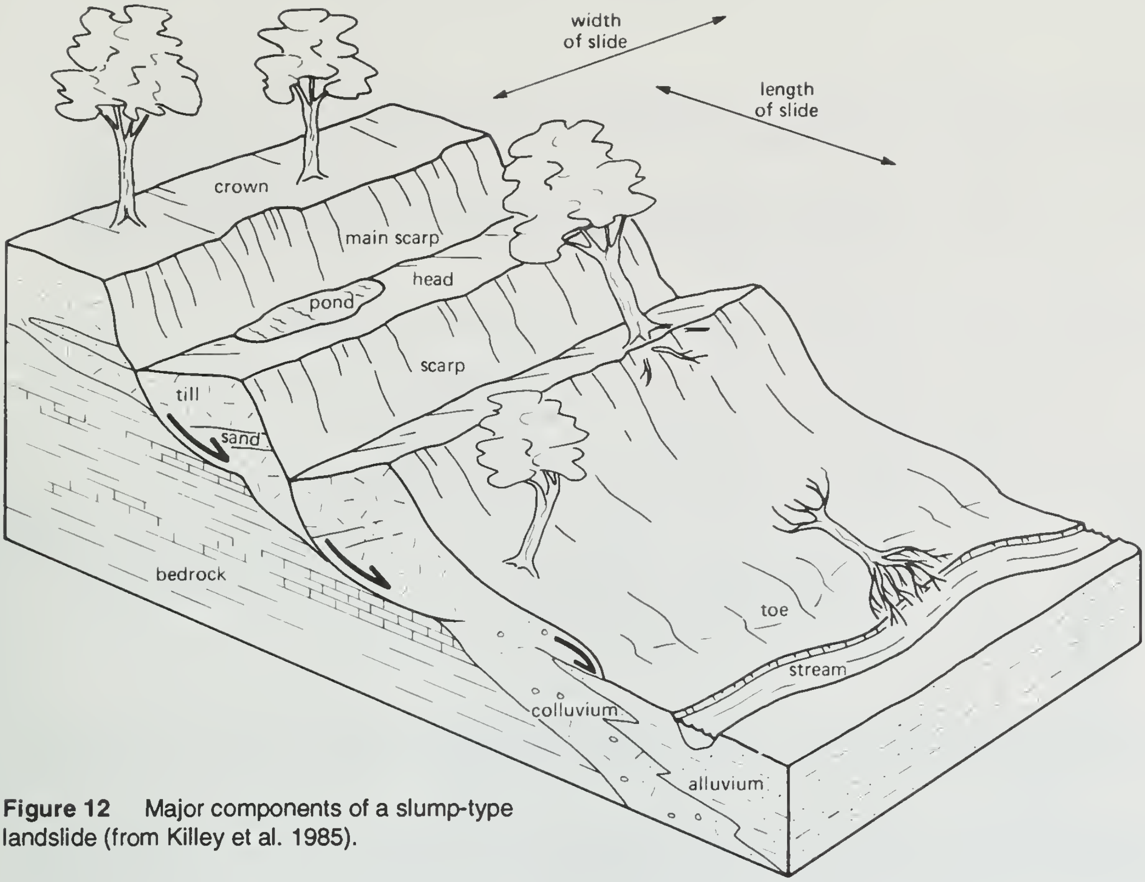


Figure 12 Major components of a slump-type landslide (from Killey et al. 1985).

rainfall, groundwater percolating down through the loess and glacial drift saturates these materials. Water reaching the underlying shale makes the interface slick as the water moves laterally toward the hillsides. The concentration of water on the less permeable bedrock surface increases the pore-water pressure and lubrication that induce slumping. Figure 12 illustrates the important features of landslides.

We are standing in a place that shows evidence of stream piracy. The dashed line on the route map indicates the probable course of Tater Creek shortly after the area was glaciated and the stream bed was much higher than it is now. The broad valley without a stream noted to the west of mileage 5.9 may have been eroded by Tater Creek when it was a much larger stream carrying runoff from the melting Illinoian glaciers. This particular valley joins the Spoon River Valley about 0.5 mile east of Duncan Mills. The highest part of that sluiceway has an elevation slightly more than 510 feet msl; here the creek is about 455 feet msl. From studying the topographic map and the surrounding landscape, it can be deduced that, as early Tater Creek flowed across the area, it developed some meanders probably because of coming into contact with some resistant Pennsylvanian sandstones. We are standing along the east side of a meander loop that developed when the creek was 40 to 50 feet higher than now. As the loop increased in width, it eroded through the narrow neck of land that separated Tater Creek from Spoon River. A small east-flowing tributary to Spoon River may have been eroding its valley headward into this narrow divide and producing a small sag. Water flowing across this sag accomplished downcutting more rapidly because of the shorter distance to the river and the steeper *gradient*. Eventually, drainage was completely diverted to the Spoon River here, leaving the segment to the south high and dry except for the short, small intermittent streams that drain both ends. Trees and their foliage obscure the profile of the valley to the south. But if you walk south along the row of willows to the southwest, you can see the shape and trend of the old valley abandoned by the river.

0.0	7.25	Leave Stop 2 and CONTINUE AHEAD (north) across Tater Creek.
0.2+	7.45+	We are traveling across a flat terrace that has a surface elevation of about 510 feet msl, which is similar to the terrace noted at mileage 4.55 north of Duncan Mills.
0.25+	7.75+	Freeman Cemetery to the right at the bend in the road.
0.05	7.8+	To the right (north) look upstream into Spoon River Valley. The tree line below marks the edge of the terrace developed near the 500-foot contour.
0.35+	8.15+	CAUTION: narrow, one-lane wooden bridge over the BNRR.
0.15	8.3+	PARK along the roadside; stay out of the ditches! Do NOT cross into the field to the right (east) nor cross the fence to the left (west). CAUTION: road is narrow and traffic is relatively fast.

STOP 3 Discussion of Spoon River Valley and nearby slump (NE SE SW NE and S½ NE SW NE Sec. 1, T4N, R2E, 4th P. M., Fulton County; Duncan Mills 7.5-Minute Quadrangle [40090C2]).

Spoon River, situated in west-central Illinois, is one of the larger tributaries to the Illinois River. The East Fork of Spoon River heads just north of Neponset, Bureau County, and the West Fork heads in the southwestern part of Kewanee, Henry County (fig. 13). These two forks, which originate just west of the Wisconsinan Bloomington Moraine, join to form the main channel of Spoon River near the center of Stark County. They and their tributaries were formed by Wisconsinan glacial meltwater, which they carried southward across the Illinoian till plain. The Spoon flows through a winding course south and west across Peoria, Knox, and Fulton Counties to its confluence with the Illinois River opposite Havana. The watershed, which encompasses 1,820 square miles, is 115 miles long and a maximum of 54 miles wide. All or parts of nine counties lie within the Spoon River watershed: Bureau, Fulton, Henry, Knox, Marshall, McDonough, Peoria, Stark, and Warren.
Spoon River drops approximately 406 feet throughout its length, an average of about 3.5 feet per mile. From the north end of the field trip at Ellisville, the river drops about 65 feet in 55 miles, or 1.18 feet per mile. Therefore, the greatest amount of fall (the steepest gradient) is in the first 60 miles, an average of 5.7 feet per mile. Wanless (1957) reported that the gradient of the Spoon River is relatively constant throughout part of the field trip area but, below Duncan Mills, the gradient changes to 3 inches per mile for the last 13 miles to the Illinois River.

The average width of Spoon River is 100 to 200 feet at low-water stage when it is only 2 or 3 feet deep. Floods are frequent, but generally brief. At highest flood stage, the river is 1½ miles wide and more than 20 feet deep. The river meanders from side to side, widening its valley by lateral erosion of bedrock, glacial materials, or terrace deposits. Although it usually transports fine sand and silt, some gravel is carried during flood stages. Its alluvium consists mostly of fine sand and silt. At its mouth, Spoon River, which is bordered by low natural levees, has built a large fan into the Illinois.

The Spoon Valley varies in width from about 2½ miles near its juncture with the Illinois Valley to about 0.3 of a mile upstream between Bernadotte and Seville; above Seville it is about 1½ miles wide. The wide parts of the valley correspond with pre-Illinoian valleys where the bedrock surface is relatively low; the narrow sections are entrenched mainly in bedrock.

Figure 13 Spoon River watershed map (Harman 1916).

According to Wanless, terrace remnants are common along both sides of the valley, even in the narrow portions. Outwash and slackwater terrace remnants related to the Bloomington moraine are preserved for many miles up the Spoon River. They consist of loess- or silt-covered benches that range from 480 to 550 feet msl; generally they are about 40 feet above the streams in their present lower courses. The Havana terrace, 485 to 465 feet, can be identified as far upstream as the mouth of Big Creek, about 1.3 miles north of here. Below us, to the east, is a Bloomington slackwater terrace with an elevation of 490+ feet; the tree line on the far side separates it from the rest of the lower portion of the valley.

About 300 feet northwest of here on the southwest side of the road is a classic example of erosion and slumping of glacial materials. A low berm was constructed around the outer edges of the upland to control surface water runoff and prevent gullying. A narrow lane with a berm connected the two pastures that were separated by a southwest-oriented large, steep gully (fig. 14a). As you can see, the berm was breeched and severe erosion has taken place along the lane be-

Figure 14 (a, top) Breeched berm at downstream edge of lane that is eroded in foreground. (b, bottom) Breeched berm with a narrow ledge of the lane to the left. View west from gravel road (photos R. J. Jacobson).

hind the berm. The walls of the eroded cut are vertical through the loess (fig. 14b). Heavy rains this spring have exacerbated the situation.

0.0	8.3+	Leave Stop 3 and CONTINUE AHEAD (north and west).
1.6+	9.95	TURN RIGHT (north) at T-intersection (1250N/1050E).
0.5	10.45	TURN LEFT (west) at T-intersection (1300N/1050E).

1.55	12.0+	CAUTION: Crossroad. CONTINUE AHEAD (west). The former Elrod School was located on the northwest corner.
1.0+	13.0+	TURN LEFT (south) at T-intersection (1340N/800E). The route for the next 0.4+ of a mile is along a part of the east boundary of the abandoned 17,750 acre World War II Camp Ellis Military Reservation. According to Bordner (1983), Camp Ellis was the largest camp of its kind.
0.35+	13.4+	TURN RIGHT (west) at T-intersection (1300N/800E).
0.1+	13.5+	Route crosses NNW-SSE landing strip of Camp Ellis.
0.4+	13.9+	Route crosses NE-SW Camp Ellis Landing Strip. The flat uplands here were ideal for an airfield location. Reclamation of the area makes it extremely difficult to see the exact location of the airstrips.
0.45+	14.4+	STOP: 2-way at Ipava/Smithfield Blacktop (1300N/700E). This blacktop is a segment of the Spoon River Scenic Drive. CONTINUE AHEAD (west).
1.05	15.45+	CAUTION: unguarded crossroads (1300N/600E). TURN RIGHT (north) by old wire corn crib.
0.65	16.1	Two concrete markers and some abutments crossing the ditch to the right indicate the entrance to the general Construction Tools and Equipment Area of Camp Ellis. According to Bordner (1983), Quartermaster, Engineer, and Medical specialties trained at Camp Ellis; 456 units trained here in 58 different skills. This facility was also a detention camp for German prisoners of war. After World War II the camp was closed and the government offered the land for sale—first choice was to the pre-WW II owners, then to others. The 1948 Edition of the Smithfield 7.5-minute Quadrangle shows a crossroads here. That road has been abandoned and reclaimed for field crops. Reclamation here appears to have been quite successful, as no evidence of the old road remains. In the distance, an old concrete water tower and a few brick chimneys are about all that remain of this large military reservation.
0.25	16.35+	CAUTION: T-intersection from left (1390N/600E). Old concrete footings and walls to the west appear to be the target area of the firing range.
0.05+	16.4+	To the left are concrete walls of what might possibly be ammunition bunkers.
0.2+	16.65+	Roadside dumping on the right. The stream valley to the right is part of the type section of the Pennsylvanian Bernadotte Cyclothem.
0.05	16.7+	CAUTION: descend hill.
0.4	17.1+	CAUTION: enter village of Bernadotte.
0.15	17.35+	STOP: 2-way at crossroads (1460N/655E). TURN LEFT (west).
0.05	17.4+	PARK on the right side of the street but beyond the bank of mailboxes. Do NOT block driveways, mailboxes, or restaurant.

STOP 4 Lunch at Bernadotte Community Park (SE NE SE NW Sec. 19, T5N, R2E, 4th P. M., Fulton County; Smithfield 7.5-Minute Quadrangle [40090D3]).

This is the site of the three-story Bernadotte Grist Mill (1830-1930). The original dam was wooden; the present concrete dam was constructed by the Army to ensure an adequate water supply for Camp Ellis. The water treatment plant was located here in Bernadotte and processed water went to two large water towers on the upland to the south.

The 80 foot, two-decker, paddle-wheel steamboat *Ruby* carried party-goers upstream from the dam for about 3 miles to a popular picnic area. People from Peoria reportedly came to Bernadotte to take the boat trip. The iron bridge downstream from the park replaced a two-lane covered bridge that was built in the mid-1840s. Bernadotte was reported to have been a station on the Underground Railway in the mid-1800s.

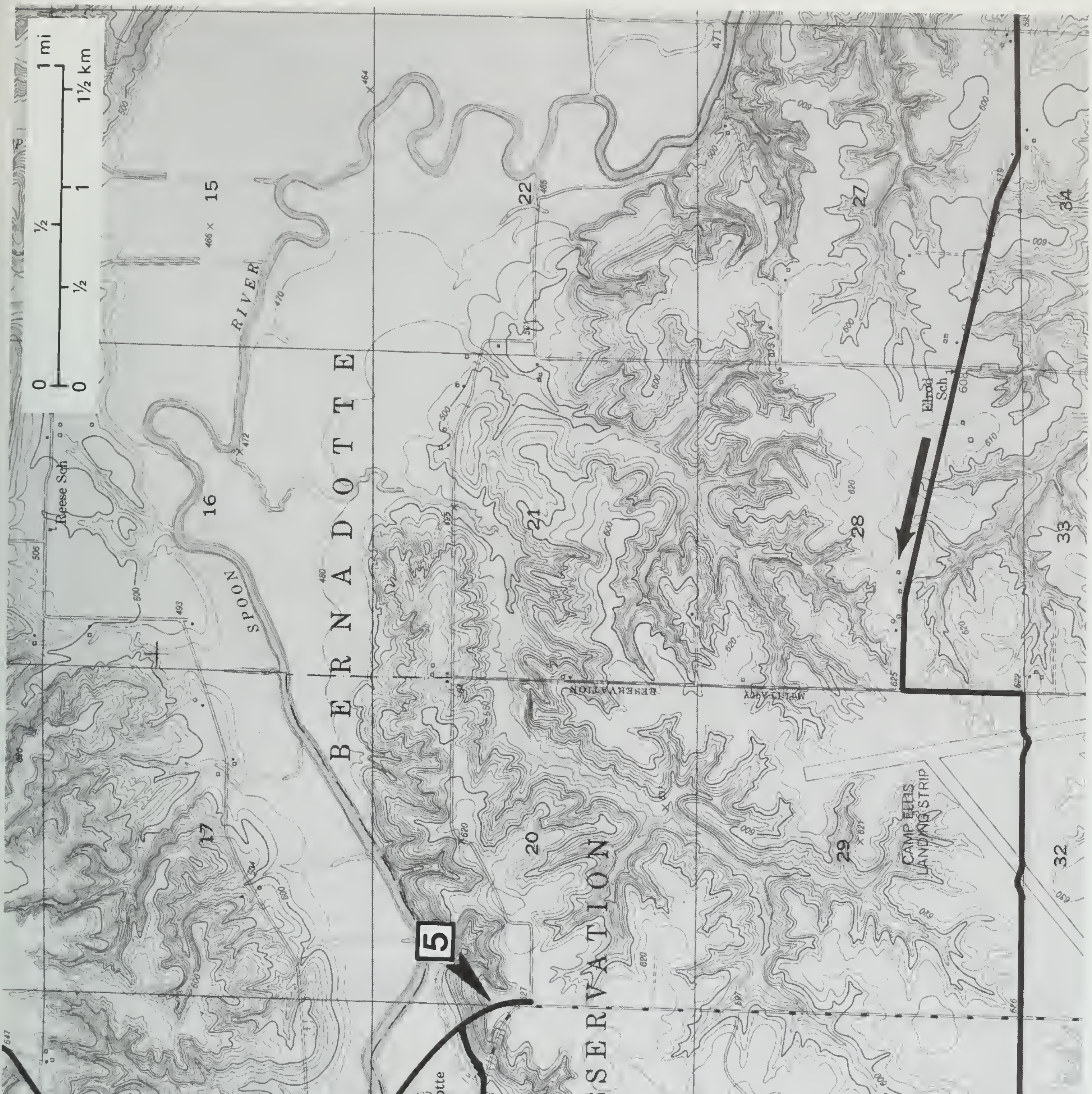
0.0	17.4+	Leave Stop #4 and TURN AROUND and CONTINUE AHEAD (east).
0.4	17.8+	STOP: 1-way at T-intersection with Ipava Smithfield blacktop. TURN RIGHT (south) up the hill.
0.05	17.85+	CAUTION: landslide repair zone. Continue ahead (south).
0.1	17.95+	PARK along roadside as far off the blacktop as you can safely. CAUTION: poor visibility from the south and fast traffic. STAY OFF the road.

STOP 5 Discussion of relationship of surface materials and slumping in this roadcut (NE SE SE NE and S½ NE SE NE Sec. 19, T5N, R2E, 4th P. M., Fulton County; Smithfield 7.5-Minute Quadrangle [40090D3]).

At the time we examined this site in late April, slumping had damaged most of the road and taken out the guardrail on the downslope side of the road. The repair line in the blacktop shows the extent of the original damage. The roadway has been filled back in and topped with loose gravel over fill. Talks with local people indicate that this problem has been here since the road first opened in 1983. One can see that this road has been built on top of a ramp constructed from fill, which here consists of a mixture of pieces of shale, siltstone, and coal in a silt matrix, probably loess. (The loess in this area is approximately 10 feet thick.)

We made a series of observations to try to determine the cause of the slumping here. First, it was necessary to establish the geologic setting. Regionally, beneath the loess is approximately 20 feet of Illinoian diamicton of the Hulick Till Member, Glasford Formation. On the hillside above the concrete ditch liner, several minor slumps can be seen. Generally one can deduce that till lies below the loess because of the gravel left as a lag on the clayey ground surface where exposed through the grass. About halfway down the slope between the T-intersection and the slumped area, shaly siltstone crops out near the ditch on the upslope side of the road. When conditions are right, the bedrock provides a surface on which overlying glacial material may slide when the contact intercepts a slope such as a roadcut or a stream valley. Here, the top of the slump appears to be generally near the elevation of the bedrock surface.

Second, it is necessary to recognize that, although several factors usually contribute to slumping, water is usually the immediate culprit, and the 1993 spring season has been rainy. Once rainwater has percolated into the ground, it generally finds its way through the fill (which is not com-



0 ½ 1 mi
0 ½ 1 1½ km
BERNADOTTE
MILITARY RESERVATION
SPOON
RIVER
Reese Sch
Elrod Sch
Bernadotte Bridge
CAMP ELLIS LANDING STRIP
LUNCH
4
5

Figure 15 (a, left) Water disappearing through crack in concrete ditch liner. (b, above) Holes caused by piping along side of concrete ditch liner that feed surface water to a subsurface conduit probably below the concrete (photos D. L. Reinertsen).

pacted to the extent that undisturbed glacial till is) in a direction with both lateral and downward components, in this case across beneath the road and down toward the creek that occupies the valley at the base of the slope.

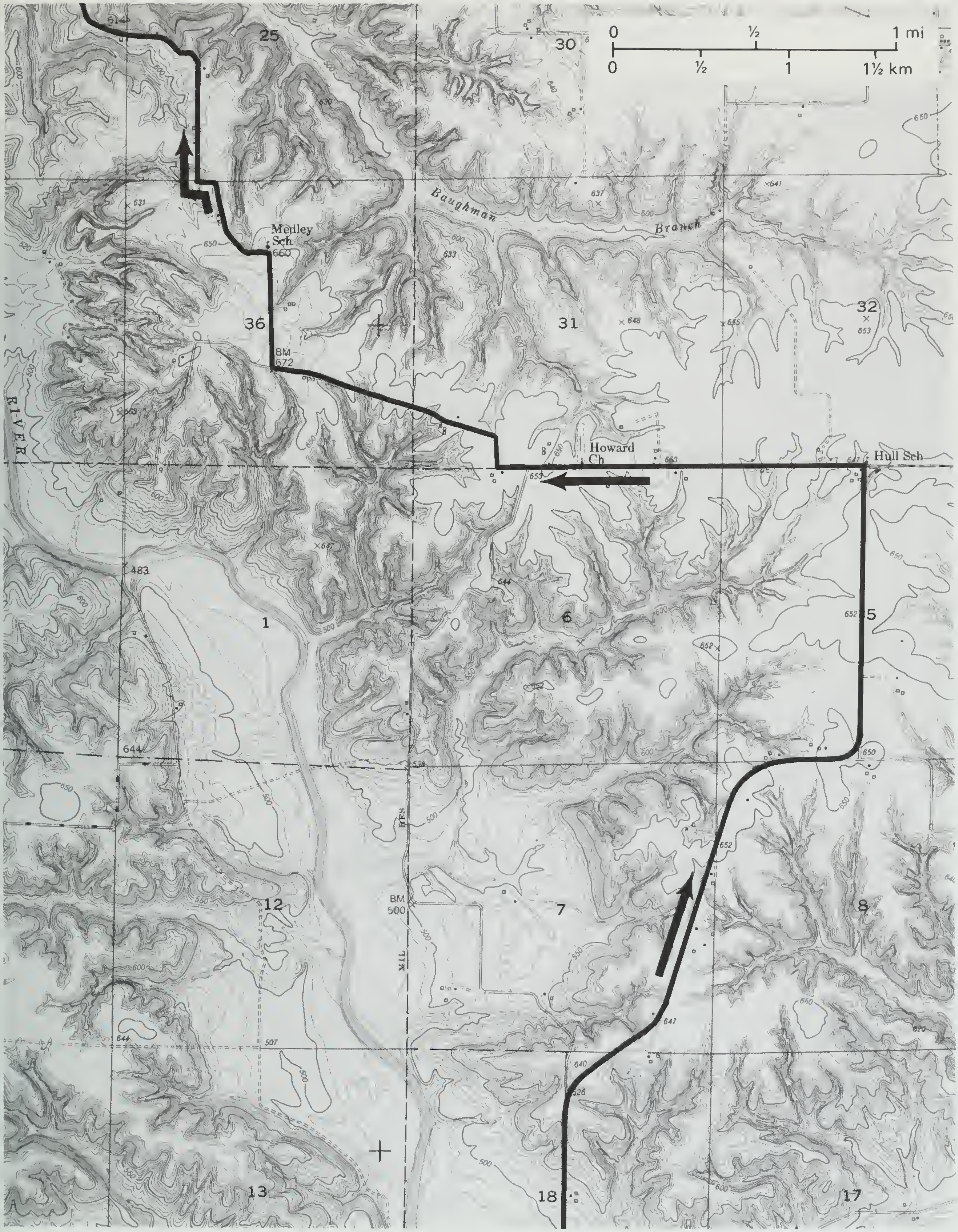
Third, the road has concrete-lined ditches on either side to help drain water away from the road into the creek. However, the ditch-liner on the downslope side of the road veers away from the road to descend into the valley, leaving much of the fill slope between the road and the ditch-liner open to saturation from rain. Also, as you walk toward the top of the hill along the upslope side of the road, you can see several cracks across the concrete ditch-liner. When we were here in late April, we observed a stream of water disappearing into several of the cracks instead of continuing on down the ditch-liner (fig. 15a), thus indicating that large quantities of water probably are entering the fill beneath the road. The water passes through the fill beneath the road toward the downward slope on the other side. We also noted several holes, measuring 8 or 10 inches to about 15 inches in diameter, along the upslope side of the ditch liner (fig. 15b). These holes are caused by "piping," which is the gradual erosion of soil material by water percolating through it. It results in caving of the soil and the formation of narrow conduits, or tunnels, in the soil through which the soil particles are removed. You could even hear water gurgling in some of these conduits. It is almost certain that water entering the fill is finding its way into the soil beneath the road, saturating it and weakening its natural cohesive strength downslope.

Also, cars, trucks, and other vehicular traffic continually cause vibrations that are transmitted from the roadway into the saturated soil. These vibrations help to weaken the cohesive strength of the soil.

From these observations, we concluded that heavy rainfall during the spring, cracks in the concrete ditch-liners allowing water to seep into and erode small tunnels in the soil underlying the road, and traffic vibrations all have contributed to the slumping that damaged the road in this area.

If you were the road commissioner, what would you do to remedy the situation here?

0.0	17.95+	Leave Stop 5 and CONTINUE AHEAD up the hill.


0
½
1 mi
0
½
1
1½ km
25
30
36
31
32
1
6
5
12
7
8
13
18
17
Medley
Sch
660
BM
672
Baughman
Branch
Howard
Ch
Hull Sch
RIVER
BM
500
483
644
650
600
500
550
653
652
647
641
648
655
631
637
633
640
626
538
507

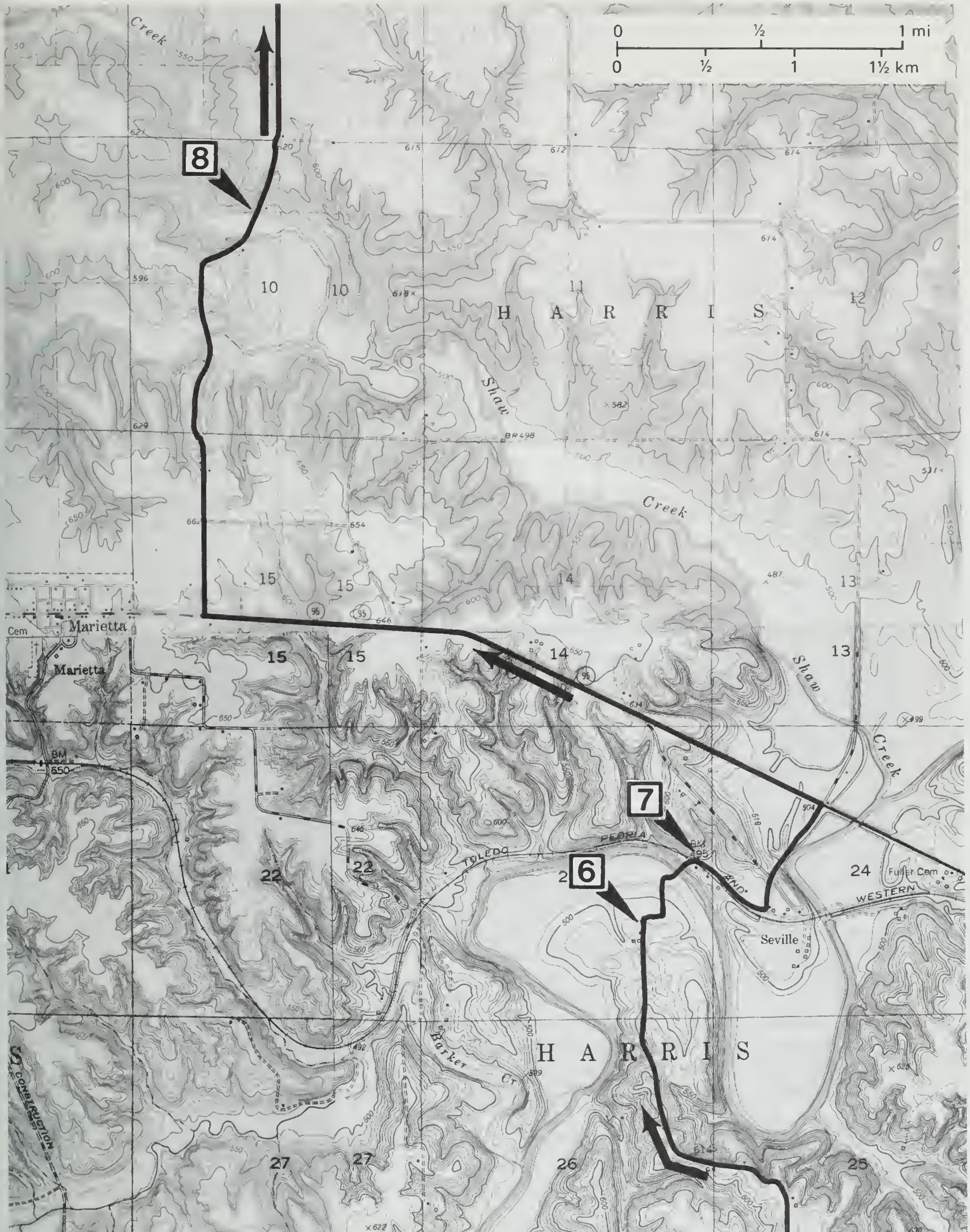
0.1+	18.1	TURN AROUND at the T-intersection from the left (1450N/700E) and CONTINUE AHEAD (north) down the hill.
0.5+	18.6+	Cross Spoon River bridge.
0.35+	18.95+	T-intersection from right (east): Lewistown Road (1520N/655E). CONTINUE AHEAD (north) on the blacktop for about 3.3 miles.
3.15+	22.15	Prepare to leave blacktop at right curve ahead.
0.15+	22.3+	Leave blacktop and CONTINUE AHEAD (north).
0.05+	22.35+	CAUTION: T-intersection (1800N/750E). TURN LEFT (west). You will travel west and north for the next 2.2 miles.
2.2+	24.55+	CAUTION: T-intersection (1835N/550E). TURN RIGHT (north).
1.85+	26.45+	To the west, down the slope, is an abandoned quarry in the Saint Louis Limestone. It is also exposed in Barker Creek on the west side of the Spoon River. The exposures indicate that this is a Mississippian bedrock high or hilltop that sticks up higher than the surrounding bedrock surface in this area. Pennsylvanian strata are draped across this bedrock high. Also note on the map that the bedrock controls the width of the Spoon River Valley in this vicinity; the valley is fairly narrow compared with areas upstream and downstream. Northeast from here, the valley loops around and is controlled by the resistant bedrock in this part of the valley.
0.55+	27.05+	PARK along roadside across from the entrance to the Black sand and gravel pit of Paving Materials Company. Be careful of traffic. Do NOT climb on piles, nor move any material from one pile to another. STAY AWAY from ALL equipment.

STOP 6 Discussion of the origin of the materials found here. We'll also collect some rock samples (SW NE SE Sec. 23, T6N, R1E, 4th P. M., Fulton County; Smithfield 7.5-Minute Quadrangle [40090D3]).

At this operation, alluvial gravels deposited as a point bar on the inside of a meander along the Spoon River are being recovered. Major meltwater floods along the Illinois River during Wisconsinan time caused floodwaters to back up and pond in the Spoon River Valley. Silt and clay slowly settled out of the ponded water and accumulated layer upon thin layer in the relatively quiet water. The percentage of silt and clay varied from layer to layer, but the deposit accumulated to form constructional slackwater terraces at elevations of about 530 feet msl near Seville. These slackwater terrace deposits bury normal stream alluvium.

After the glacial floodwaters receded, Spoon River eroded its channel down through the slackwater and pre-slackwater deposits to bedrock. The modern floodplain is a nearly flat, constructional terrace composed of mixed sand, silt, and clay at an elevation of 490 feet. Spoon River is restricted to a narrow channel that swings from side to side on the valley floor.

0.0	27.05+	Leave Stop 6 and CONTINUE AHEAD (north) to Seville.
0.25+	27.35	Cross Spoon River.


0 ½ 1 mi
0 ½ 1 1½ km
8
7
6
H A R R I S
Shaw
Creek
Marietta
Seville
PEORIA
TOLEDO
WESTERN
Fuller Cem
Barker
Cem
10
11
12
13
14
15
22
24
25
26
27

0.05	27.4	CAUTION: double unguarded Toledo Peoria and Western (TP&W) railroad crossing. Visibility is limited because the track curves.
0.05	27.45	PARK along roadside (SE SE SE NE Sec. 23, T6N, R1E, 4th P.M.; Smithfield 7.5-Minute Quadrangle), but NOT on the tracks NOR the bridge! Walk west to the exposures along the north side of the tracks. CAUTION: BE ALERT and EVER MINDFUL that trains cannot stop quickly!!
		NOTE: TP&W must grant permission to visit these exposures.

STOP 7 Examination of Pennsylvanian middle Tradewater Formation strata (N½ SE SW NE Sec. 23, T6N, R1E, 4th P. M., Fulton County; Smithfield 7.5-Minute Quadrangle [40090D3]).

The Seville area is one of the best locations to see the effects of pre-Pennsylvanian topography on Pennsylvanian sedimentation. Here we will see mainly some of the middle Tradewater Formation strata (fig.16). From near the top of the north valley wall down to river level, you may find Pennsylvanian strata from the Carbondale Formation to the base of the Tradewater Formation. Locally at river level, Tradewater strata can be observed resting unconformably on the Mississippian St. Louis Limestone.

Rocks exposed along the north side of the tracks consist of strata from the claystone just above the DeLong Coal down to the claystone below the Rock Island Coal (fig. 16). Of special interest is the extreme lateral variability and the pinching out of the basal Pennsylvanian rock units.

The Seville Limestone (fig. 17a), the underlying black shale, and the Rock Island Coal were deposited on an irregular Mississippian surface that was the result of a long period of erosion. The surface, which generally consists of deep valleys separated by upland areas, represents a major unconformity present at the base of the Pennsylvanian across much of the Illinois Basin. In the field trip area, the irregularity of the surface was further enhanced by uplift along a small anticline; the top of the Mississippian St. Louis Limestone has more than 70 feet of local topographic relief. It appears that a prominent limestone hill existed in the north half of Section 26, just to the south of us. In the sag north of the hill, where we are, lies a relatively thick accumulation of Pennsylvanian sediments.

In this area, by the time peat had accumulated for the Rock Island Coal, some Pennsylvanian sediments had begun to partially drape the irregular Mississippian surface. In some areas of western Illinois, the Rock Island Coal lies very close to the Pennsylvanian unconformity with very little sediment between. As a result, the topography was still quite irregular, and the thicker deposits of peat, black mud, and carbonate mud (now the Rock Island Coal, overlying black shale, and Seville Limestone) accumulated in a number of valleys that formed estuaries along the coastal shoreline of the shallow inland sea. The Rock Island Coal is as much as 12 feet thick in some of these valleys fills, but it can be only a few inches thick just a stone's throw away.

Here we can see an outcrop where more than 4 feet of Seville Limestone pinches out to the west until it disappears. This marine unit is very fossiliferous, mainly brachiopods and bryozoans, but other typical marine fossils also may be found. The Seville Limestone occurs as discontinuous lenses that can be traced from western Kentucky northwestward to Rock Island County.

In the western part of the railroad cut, beyond where the Seville disappears, a silty gray shale (fig. 17b) occurs below the coal and claystone interval containing the Brush to DeLong Coals above the Rock Island Coal. The Rock Island Coal is at track level and covered. The gray shale is very

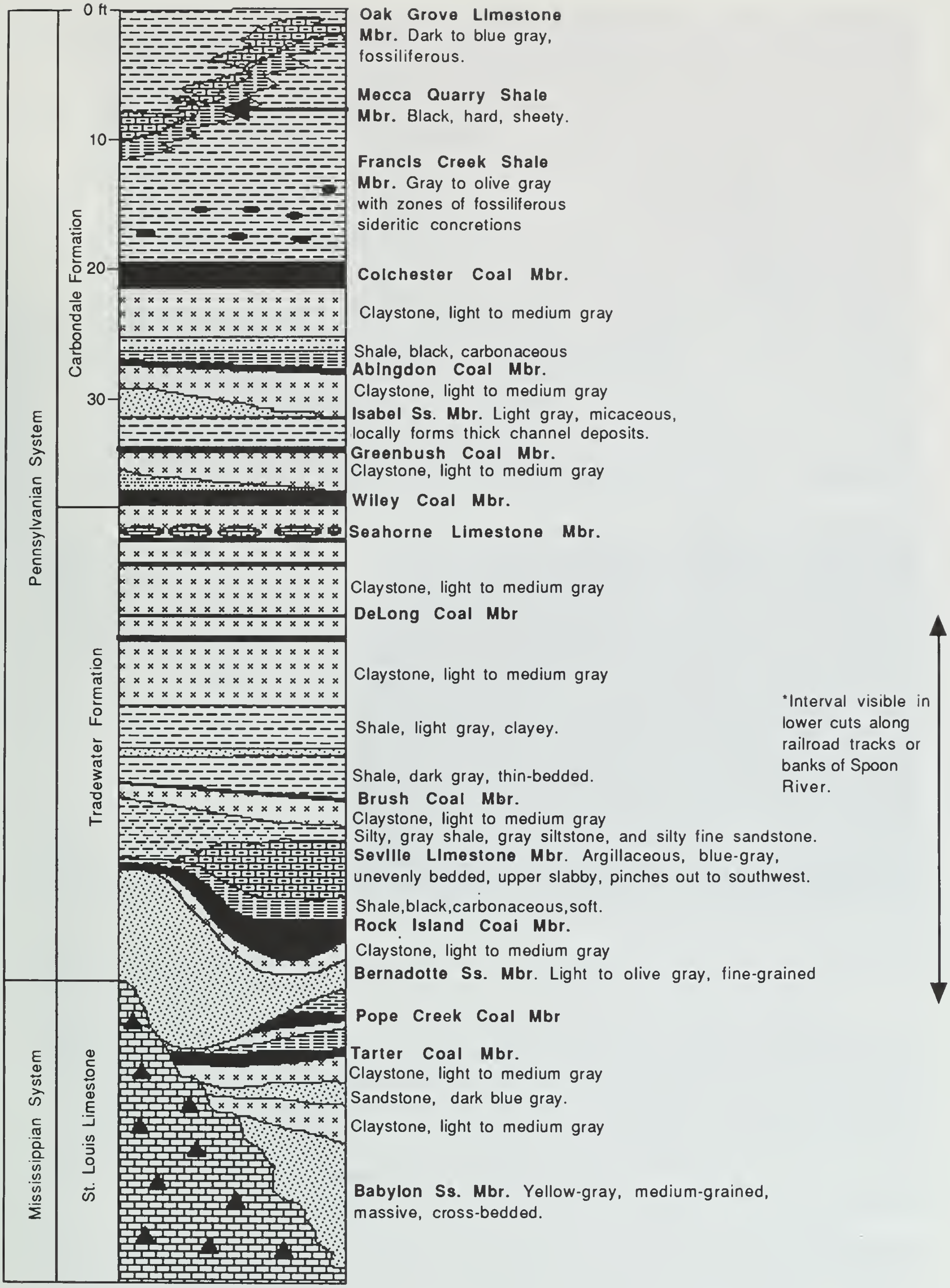


Figure 16 Generalized stratigraphic section of strata exposed at Stop 7 and vicinity (after Wanless 1957, geologic sections 32 and 33).

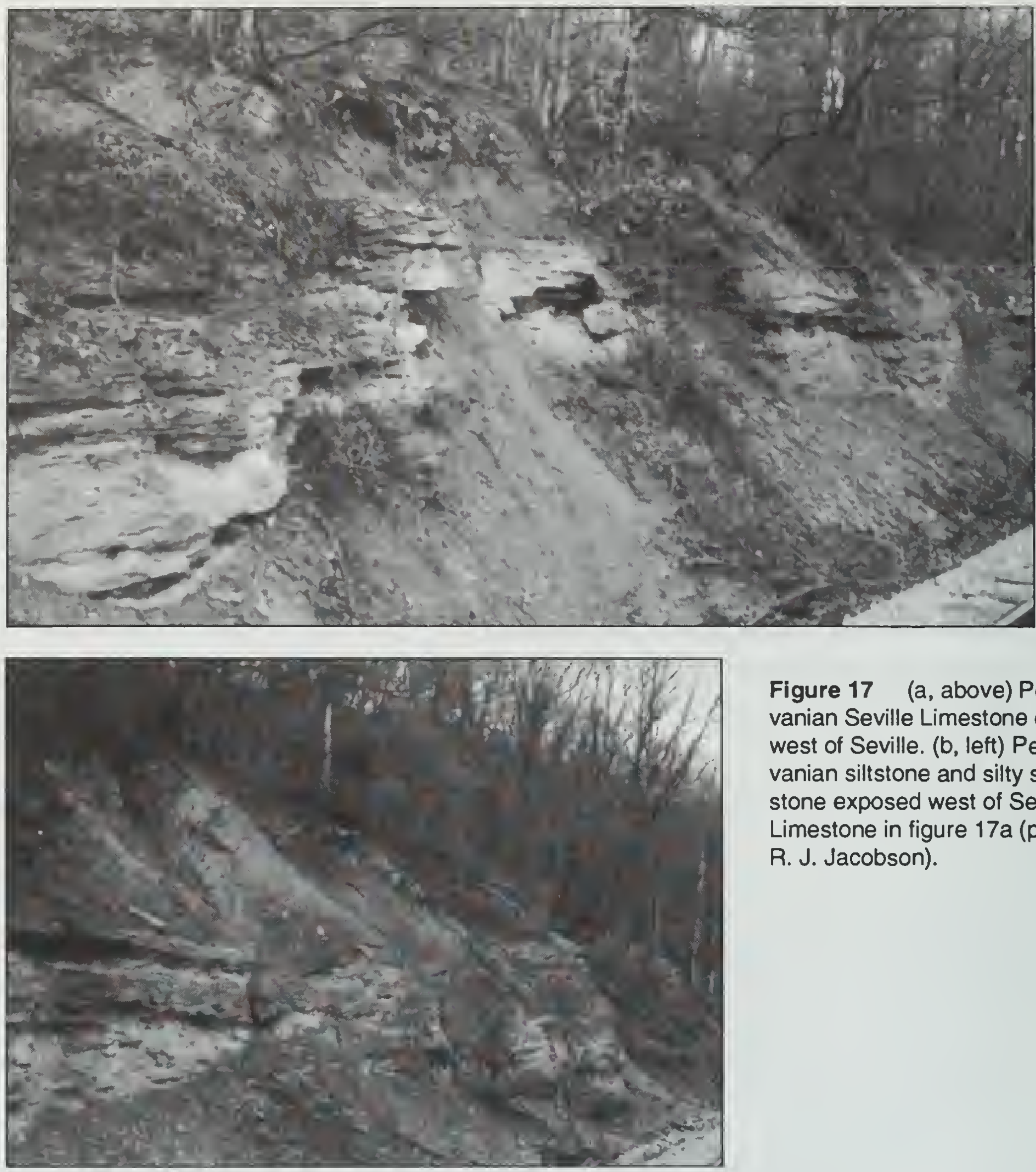


Figure 17 (a, above) Pennsylvanian Seville Limestone exposed west of Seville. (b, left) Pennsylvanian siltstone and silty sandstone exposed west of Seville Limestone in figure 17a (photos R. J. Jacobson).

finely laminated; locally the dark and light laminations exhibit slump features that are the result of soft sediment deformation before lithification.

When Spoon River is low, the Bernadotte Sandstone that lies below the Rock Island Coal can be seen along here. We saw this sandstone at Stops 1 and 2, and we'll see it again at Stop 8. On the basis of field data collected in this vicinity, it has been suggested that the Bernadotte Sandstone forms a syncline in the sag (noted earlier on the north side of the limestone hill in Section 26) because the thicker sediments in the sag between the Bernadotte and the St. Louis Limestone were more compacted than the thin sediments deposited on the limestone hill to the south. At some places along the Spoon River, particularly when the water is low, Mississippian St. Louis Limestone is exposed, especially a short distance southwest of here.

Although the Isabel Sandstone generally occurs as a thin sheet deposit, it locally may occur as a channel. One such channel exists from the northwest corner to the center of Section 23. This

channel cuts as deep as the top of the Bernadotte Sandstone. The younger sandstones are *micaceous* (muscovite), whereas the Bernadotte is not.

0.0	27.45	Leave Stop 7 and CONTINUE AHEAD (southeast) through Seville (pronounced Seaville, which was the original spelling).
0.25+	27.7+	TURN LEFT (north) at intersection (2040N/520E).
0.1+	27.8+	BEAR RIGHT (northeast) down the hill at the Y-intersection (2050N/520E). Isabel Sandstone Member exposed surrounding the intersection.
0.3	28.1+	STOP: 2-way. CAUTION: TURN LEFT (northwest) on SR 95. Fast traffic!
2.15	30.25+	Prepare to turn right.
0.1+	30.4+	TURN RIGHT (north) on gravel road.
0.75+	31.15+	CAUTION: slump along right roadside.
0.2+	31.4+	Cross South Fork Shaw Creek. Pennsylvanian Bernadotte Sandstone Member is exposed along the north valley wall to the right.
0.25+	31.65+	View ahead across Shaw Creek shows slump scars across the face of the southwesterly-facing slope.
0.15+	31.8+	Cross Shaw Creek. The Bernadotte Sandstone Member crops out along the south valley wall just east of the bridge.
0.1	31.9+	PARK along roadside. Do NOT block gates, driveways, bridge, or road. Do NOT climb over fences!

STOP 8 Pennsylvanian strata of the Tradewater Formation (formerly Abbott and Spoon Formations) and a large recent slump are evident along the north bank of Shaw Creek (gate: SW SE NE NW Sec. 10, T6N, R1E, 4th P. M., Fulton County; Bushnell East 7.5-Minute Quadrangle [40090E4]).

Here the Rock Island Coal is very thin and overlain by a marine black shale (fig. 18). The Seville Limestone that should occur above the black shale is missing; instead, a thin silty sandstone and several feet of siltstone immediately overlie the black shale. We can closely examine the claystone-rich interval overlying the Rock Island Coal that contains the Brush and DeLong Coals. The Bernadotte Sandstone, which underlies the Rock Island Coal underclay, also is well exposed in this outcrop, as is the 1 foot coal tentatively identified as the Pope Creek Coal (fig. 19a). The remainder of the Tradewater strata is covered by alluvium, but we know from nearby drill hole data that the base of the Pennsylvanian and its unconformable contact with the Mississippian St. Louis Limestone is only 10 to 15 feet below the base of the Pope Creek Coal.

Much of the same Tradewater stratigraphic interval we have seen at Stops 1, 2, and 7 is exposed here. You should notice that the lithologies below the Brush and DeLong Coals are quite variable. In addition, coals (e.g., the Rock Island and Pope Creek), limestones (e.g., Seville), and sandstones (e.g., Bernadotte) thicken, thin, and disappear partly because of the irregular underlying Mississippian erosion surface. Here, nearly the entire Tradewater (about 50 feet) is exposed,

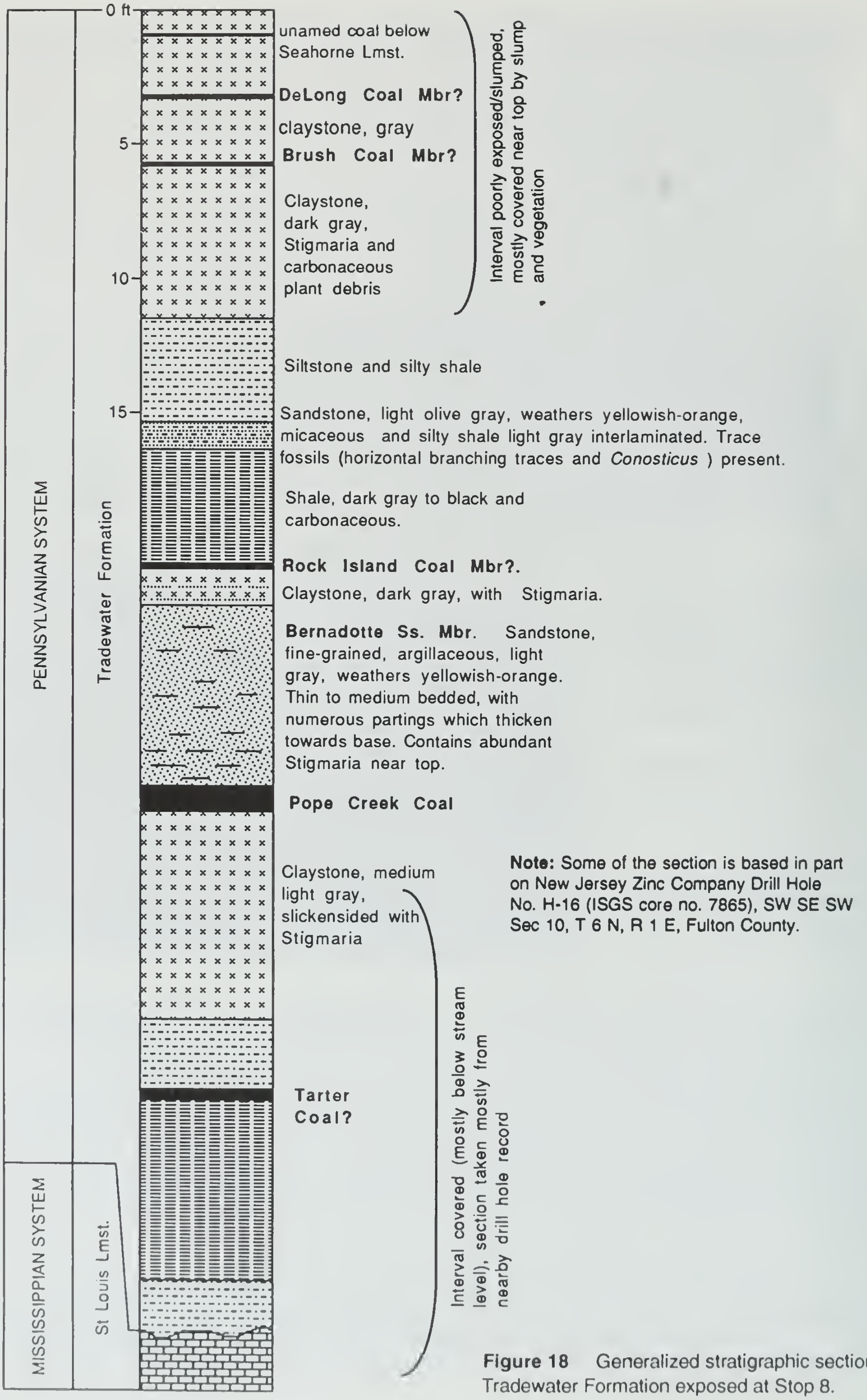


Figure 18 Generalized stratigraphic section of the Tradewater Formation exposed at Stop 8.

Figure 19 (a, right) Exposure of Bernadotte Sandstone and Pope Creek (?) Coal on north valley wall of Shaw Creek (photo D. L. Reinertsen). (b, below) Typical hummocky topography of earth slump east of figure 19a (photo R. J. Jacobson).

except for the basal 10 to 15 feet, which illustrates just how thin this formation can be in western Illinois. The Tradewater Formation basically is a thin drape of sediments over much of the area, except in the paleovalleys at the basal unconformity. In southern Illinois, however, which is closer to the depocenter of the Illinois Basin, the Tradewater typically is several hundred feet thick. In northern and western Illinois, sedimentation was limited prior to the deposition of the overlying Carbondale Formation.

Several types of fossils are present here, especially carbonized root traces (*Stigmaria*) from the plants that formed the peat which became the Rock Island Coal. These root traces also are present in the underclay of the Pope Creek Coal and in the claystones associated with the Brush and DeLong Coals.

Of special note here are some trace fossils in the silty sandstone above the black shale overlying the thin Rock Island Coal. Horizontal feeding traces are the most abundant (look like tubes or burrows or fillings from them), but less common is the diagnostic trace fossil, *Conosticus,* which is the resting trace of the sea anemone. Its presence clearly indicates that the sandstone was deposited in a marine environment. Although many Pennsylvanian sandstones were originally thought to be fluvial, geologists working for the ISGS in southern Illinois have found similar marine trace fossils in a number of sandstones in the Tradewater and the underlying Caseyville Formation. Thus, these types of fossils are not only interesting curiosities, but they also can be of great importance to geologists studying how and where Pennsylvanian rocks formed. Understanding the depositional environments in which these rocks formed is crucial to predicting the

chemical quality of coals occurring beneath them. For example, coals that are overlain by marine strata are typically much higher in sulfur than those that are overlain by thick deposits of nonmarine rocks. Locating low-sulfur coals is of major importance to coal geologists in these days of tough environmental restrictions against sulfur pollution.

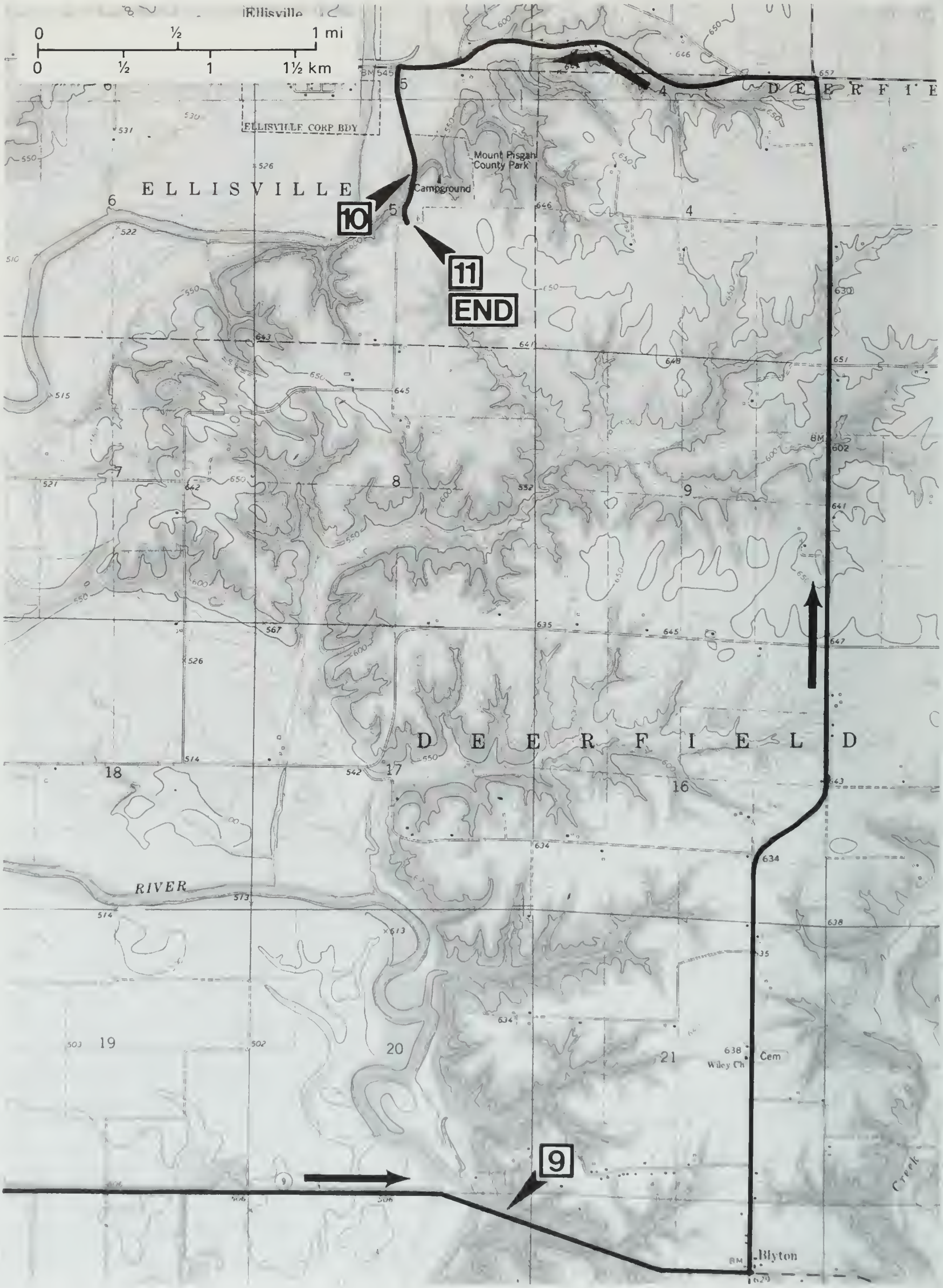
To the east, along the hill from the exposure of Pennsylvanian rocks, a large slump area consisting of multiple slump blocks with numerous scarps is observable across the entire hillside. The hummocky topography of a typical slump surface is evident (fig. 19b). Small areas of ponded water have formed on the tops of slump blocks, which have been rotated backward slightly. Many tension cracks can be seen in the surfaces of the slump blocks. Some of the scarps expose what appears to be a thin smear of colluvium (slumped material consisting of clayey soil containing some sandstone and siltstone cobbles) over the bedrock. In addition to the water added to the slope during the rainy spring season, the slump is located on a hillside above the outside of a meander in the creek below, indicating that gradual erosion of the outer bank of the creek in this area continually removes support at the toe of the slope, encouraging the slumping.

0.0	31.9+	Leave Stop 8 and CONTINUE AHEAD (north) up the hill.
0.8+	32.75	STOP: 1-way at Y-intersection (2350N/350E). CONTINUE AHEAD (north).
0.55+	33.3+	STOP: 1-way at T-intersection with blacktop (2410N/ 350E). CAUTION: limited visibility and fast traffic from west. TURN RIGHT (north).
1.8+	35.1+	CAUTION: Y-intersection (2600N/350E). CURVE RIGHT (east).
0.1+	35.25+	STOP: 1-way at SR9. CAUTION: limited visibility from west and north; fast traffic. BEAR RIGHT (east).
2.25	37.5+	Descend west valley wall of Spoon River. Notice slumping on right side as we go downhill.
0.5	38.0+	Crossing wide valley flat of Spoon River.
0.5	38.5+	Abandoned gravel pit to left.
1.0+	39.55+	Cross Spoon River.
0.15	39.7+	PARK on roadside as far off the highway as you can safely. CAUTION: fast traffic. Do NOT STAND or loiter on the highway.

STOP 9 Discussion of large slump on the north side of SR 9 (S½ NE NE NE Sec.29, T7N, R2E, 4th P. M., Fulton County; Blyton 7.5-Minute Quadrangle [40090E3]).

The feature on the north side of the highway is certainly the "mother of all slumps" (RJJ)— at least on this field trip. Numerous scarps and slump blocks are visible at this large slump (fig.20a). The broad extensive scarps high on the hillside expose the Hulick Till Member of the Illinoian Glasford Formation. In some other slumps about 1/2 mile east of here along the highway, the same tough clayey *diamicton* of the Hulick is also exposed and contains thin lenses of sand, which contribute to the instability of the saturated material when intersecting a slope such as this. Earlier slumping caused the highway department to cut the slope back at a shallower angle and armor the toe of the slope with large cobbles and boulders. However, the armoring of the toe was

0
½
1 mi
0
½
1
1½ km
BM
637
626
629
522
22
22
23
24
628
621
625
621
628
625
566
27
27
26
25
622
604
590
Checkrow
Rigdon Cem
619
580
BR 559
589
536
504
34
34
609
35
508
36
Shoal
501
624
618
612
493
Creek
3
3
606
615
2
605
1
615
503
620
615
612
614



0
½
1 mi
0
½
1
1½ km
Ellisville
ELLISVILLE CORP BDY
ELLISVILLE
Mount Pisgah County Park
Campground
10
11
END
DEERFIELD
D E E R F I E L D
RIVER
Wiley Ch
Cem
Blyton
Creek
9

Figure 20 (a, top) Numerous slump scarps exposing Hulick Till Member at Stop 9 east of Spoon River. (b, right) Deformation of rock armor along toe of slump above. Note that toe has oozed beneath the armor into and across the ditch (photos D. L. Reineretsen).

apparently inadequate to contain the movement, although it may well have been successful in keeping the toe of the slump from moving out onto the highway. From a vantage point farther east along the highway one can see a distinct S-curve in the armoring. We assume that it was originally laid down parallel to the highway and that additional later slumping has moved it into its present configuration (fig. 20b).

Many aspects of typical slumping can be seen here. In addition to the numerous scarps, there are rotated slump blocks, some with ponding on their upper surfaces. Numerous tension cracks, some 2 to 3 feet deep, can be seen, as can a series of uplifted and downdropped slump blocks similar to "horst-and-graben" topography. Near the toe of the slump, compression has resulted in the highly saturated toe material rolling over on itself. Of particular interest are the differences in how material at the toe has behaved along the extent of the entire slump. In places the armoring

has remained in place and the soil has moved outward over the boulders. In other places the soil has bulged the armoring outward. In still other areas, the soil appears to have oozed beneath the armoring and doubled over onto itself into the culvert lining the highway. The ditch has been scraped clear at least once during this episode of slumping.

0.0	39.7+	Leave Stop 9 and CONTINUE AHEAD (east). USE CAUTION upon reentering the highway.
0.3	40.0+	VIEW to left of more earth slumping.
0.1+	40.1+	VIEW ahead on left of slumping that has let material down onto the shoulder and almost onto the pavement.
0.3	40.4+	Prepare to turn left.
0.15	40.55+	TURN LEFT (north) on Ellisville Road at Midway. This locality got its name because it is about halfway between Canton, 13 miles to the east, and Bushnell, 14 miles to the west, on SR 9. A short distance northwest was a small community called Blyton that was located on the old Canton-Bushnell road.
0.75+	41.35	Wiley Lutheran Church to left. Methodists shared this pioneer church until 1926 when they disbanded. CONTINUE AHEAD (north).
3.45	44.8	Stop ahead.
0.15	44.95	STOP: 4-way at intersection with Fairview and London Mills Roads (3000N/900E). TURN LEFT (west) toward Ellisville.
0.25	45.2	Begin descent of Spoon River east valley wall.
1.15	46.35	Prepare to turn left.
0.15+	46.5+	TURN LEFT (south) at T-intersection (3000N/780E) toward Mt. Pisgah. This road is just east of the Spoon River bridge at Ellisville.
0.4	46.9+	PARK along roadside. CAUTION: narrow road. *Traffic moves too fast, and the gravel is loose!*

STOP 10 Examination of Pleistocene materials in the roadcut on the east side of the road at bottom of hill (SE NW SW NE Sec. 5, T7N, R2E, 4th P. M., Fulton County; Blyton 7.5-Minute Quadrangle [40090E3]).

About 45 feet of the upper part of the Hulick Till Member of the Illinoian Glasford Formation is exposed here. It is overlain by nearly 10 feet of loess at the top of the bluff. The till is medium gray, clayey silt and contains many pebbles at this locality; some striated cobbles up to 10 inches in diameter were observed here. A detailed inspection was not possible because the exposure was too wet each time we were here working on the trip. When saturated, it has little strength in a steep slope such as this one.

As we proceed up the hill from here, note how the till and loess have slumped. The road has been cleared of slumped material periodically.

0.0	46.9+	Leave Stop 10 and CONTINUE AHEAD (south) up the hill. Note the several slumps that have developed in the east road cut.
0.15+	47.05+	TURN LEFT (east) onto drive into Mt. Pisgah County Park. PARK and then walk to the north end of the bluff.

STOP 11 View and discussion of Spoon River Valley from this vantage point (entrance: NW NW NW SE Sec. 5, T7N, R2E, 4th P. M., Fulton County; Blyton 7.5-Minute Quadrangle [40090E3]).

The magnificent view west and north from this 140-foot high promontory is one of the best in this part of the county. The community of Ellisville, formerly Sorghum City, lies just to the northwest. The first home was built there in 1828. Shortly afterwards a mill was constructed along the Spoon and the community prospered. The Opera House is about 100 years old and still hosts stage productions.

This stop is about 55 miles from the confluence of the Spoon and Illinois Rivers at Havana. The river falls 65 feet in that distance (1.18 feet per mile). We are about 60 miles from the headwaters of the Spoon River at Neponset in Bureau County. The river falls about 340 feet in this distance (an average of 5.7 feet per mile). The valley bottom, which is 1.8 miles wide at Stop 9, is only 0.3 mile wide at Ellisville because of resistant bedrock close to the surface. Just to the north of town, however, it widens to slightly more than 1 mile. To the southwest, it is about 0.5 mile wide, again controlled by resistant bedrock.

There are several places near the edge of the bluff where you can look down on the slumped areas. You can look down on the terracettes or steps that have rotated from slumping. *If it is very wet, don't stand too close to the edge or your next step could be an exceptionally long one.*

Dunes of Parkland Sand are present in the area and some of them have been mined.

End of field trip

To leave this area, TURN RIGHT (north) at the park entrance and descend the hill to the Ellisville blacktop. Then you have two options:

1) TURN LEFT (west) for Ellisville and Prairie City/Avon; *or*
2) TURN RIGHT (east) for the 4-way stop at mileage 44.95.
    a) TURN RIGHT (south) to Blyton and SR 9,
    b) TURN LEFT (north) to London Mills and SR 116, *or*
    c) CONTINUE AHEAD (east) to Fairview and SR 97.

BIBLIOGRAPHY

Atherton, E., 1971, Tectonic Development of the Eastern Interior Region of the United States in Background Materials for Symposium on Future Petroleum Potential of NPC Region 9 (Illinois Basin, Cincinnati Arch, and Northern Part of Mississippi Embayment): Illinois State Geological Survey Illinois Petroleum 96, p. 29-43.

Atherton, E., *et al*, 1971, Structure Map on Top of Precambrian Basement in Bond, D. C., *et al*, Future Petroleum Potential of Region 9, Eastern Interior in Future Petroleum Provinces of the United States—Their Geology and Potential: American Association of Petroleum Geologists Memoir 15, v. 2, p. 1165-1218.

Bell, A. H., E. Atherton, T. C. Buschbach, and D. H. Swann, 1964, Deep Oil Possibilities of the Illinois Basin: Illinois State Geological Survey Circular 368, 38 p.

Bergstrom, R. E., 1956, Groundwater Geology in Western Illinois, North Part: A Preliminary Report: Illinois State Geological Survey Circular 222, 24 p.

Bhagwat, S. B., 1987, The Future of Illinois Coal: 1994 and Beyond: Illinois State Geological Survey Illinois Mineral Note 97, 25 p.

Bordner, M. R., 1983, A Spoon River Portrait: Its History and Festivals: Bordner and Taylor publishers, 96 p.

Bordner, M. R., ed., 1987, Fulton County Illinois Heritage: Fulton County Historical and Geneological Society, Curtis Media Corporation, Dallas, Texas, 652 p.

Cady, G. H., 1952, Minable Coal Resources of Illinois: Illinois State Geological Survey Bulletin 78, 138 p.

Damberger, H. H., *et al*, 1984, Coal Industry in Illinois: Illinois State Geological Map; scale, 1:500,000; size 30 by 50 inches; color.

Ekblaw, G. E., and L. F. Athy, 1925, Glacial Kankakee Torrent in Northeastern Illinois: Geological Society of America Bulletin, v. 36, no. 2, p. 417-427.

Frye, J. C., and H. B. Willman, 1970, Pleistocene Stratigraphy of Illinois: Illinois State Geological Survey Bulletin 94, 204 p.

Harman, J. A., 1916, Reclamation of Lands Subject to Overflow in the Spoon River Valley: Illinois State Geological Survey Bulletin 32, 57 p.

Horberg, L., 1950, Bedrock Topography of Illinois: Illinois State Geological Survey Bulletin 73, 111 p.

Illinois Secretary of State, 1906, Blue Book of the State of Illinois for 1905: p. 413.

Killey, M. M., J. K. Hines, and P. B. DuMontelle, 1985, Landslide Inventory of Illinois: Illinois State Geological Survey Circular 534, 27 p.

Kosanke, R. M., J. A. Simon, H. R. Wanless, and H. B. Willman, 1960, Classification of the Pennsylvanian Strata of Illinois: Illinois State Geological Survey Report of Investigations 214, 84 p.

Leighton, M. M., G. E. Ekblaw, and L. Horberg, 1948, Physiographic Divisions of Illinois: Illinois State Geological Survey Report of Investigations 129, 19 p.

Lineback, J. A., 1979a, The Status of the Illinoian Glacial Stage, *in* Wisconsinan, Sangamonian, and Illinois Stratigraphy in Central Illinois: Illinois State Geological Survey Guidebook 13, pp. 69-78.

Lineback, J. A., 1979b, Quaternary Deposits of Illinois: Illinois State Geological Survey Map; scale, 1:500,000; size, 40 x 60 inches; color.

Masters, E. L., and J. E. Hallwas (ed.), 1915 (1992), Spoon River Anthology: An Annotated Edition: University of Illinois Press, Urbana and Chicago, 436 p.

Piskin, K., and R. E. Bergstrom, 1975, Glacial Drift in Illinois: Illinois State Geological Survey Circular 490, 35 p.

Reinertsen, D. L., 1988, A Guide to the Geology of the Canton Area, Fulton County: Illinois State Geological Survey Geological Science Field Trip Guidebook 1988B, 41 p. plus attachments.

Reinertsen, D. L., and R. S. Nelson, 1983, The Lewistown-Spoon River Area: Illinois State Geological Survey field notes.

Samson, I. E., 1992, Illinois Mineral Industry in 1990 and Preliminary Mineral Production Data for 1991: Illinois State Geological Survey Illinois Minerals 110, 43 p.

Samson, I. E., and J. M. Masters, 1992, Directory of Illinois Mineral Producers, 1992: Illinois State Geological Survey Illinois Minerals 109, 129 p.
Savage, T. E., 1922, Geology and Mineral Resources of the Avon and Canton Quadrangles: Illinois State Geological Survey Bulletin 38 (extract B), 67 p.
Smith, W. H., and D. J. Berggren, 1963, Strippable Coal Reserves of Illinois: Part 5A—Fulton, Henry, Knox, Peoria, Stark, Tazewell, and Parts of Bureau, Marshall, Mercer, and Warren Counties: Illinois State Geological Survey Circular 348, 59 p.
Treworgy, C. G., L. E. Bengal, and A. G. Dingwell, 1978, Reserves and Resources of Surface-Minable Coal in Illinois: Illinois State Geological Survey Circular 504, 44 p.
Treworgy, C. G., and M. H. Bargh, 1982, Deep-Minable Coal Resources of Illinois: Illinois State Geological Survey Circular 527, 65 p.
Treworgy, C. G., and M. H. Bargh, 1984, Coal Resources of Illinois: Colchester (No. 2), Dekoven and Jamestown, with Belle Rive, Bristol Hill, Calhoun, Friendsville, Louden, Oconee, Opdyke, Shelbyville and Trowbridge Coals: Illinois State Geological Survey Map; scale, 1:500,000; size, 30 by 50 inches; color.
Treworgy, C. G., and M. H. Bargh, 1984, Coal Resources of Illinois: Springfield (No. 5) Coal: Illinois State Geological Survey Map; scale, 1:500,000; size, 30 by 50 inches; color.
Treworgy, C. G., and M. H. Bargh, 1984, Coal Resources of Illinois: Herrin (No. 6) Coal: Illinois State Geological Survey Map; scale, 1:500,000; size, 30 by 50 inches; color.
Treworgy, J. D., 1981, Structural Features in Illinois: A Compendium: Illinois State Geological Survey Circular 519, 22 p.
Wanless, H. R., 1955, West Central Illinois: 19th Annual Tri-State Geological Conference Guidebook, Department of Geology, University of Illinois, 34 p.
Wanless, H. R., 1957, Geology and Mineral Resources of Beardstown, Glasford, Havana, and Vermont Quadrangles: Illinois State Geological Survey Bulletin 82, 233 p.
Wanless, H. R., 1958, Pennsylvanian Faunas of the Beardstown, Glasford, Havana, and Vermont Quadrangles: Illinois State Geological Survey Report of Investigations 205, 59 p.
Willman, H. B., J. A. Simon, B. M. Lynch, and V. A. Langenheim, 1968, Bibliography and Index of Illinois Geology through 1965: Illinois State Geological Survey Bulletin 92, 373 p.
Willman, H. B., *et al*, 1967, Geologic Map of Illinois: Illinois State Geological Survey Map; scale, 1:500,000; size, 40 by 56 inches; color.
Willman, H. B., *et al*, 1975, Handbook of Illinois Stratigraphy: Illinois State Geological Survey Bulletin 95, 261 p.
Worthen, A. H., 1870, Fulton County in Geology and Palaeontology: Geological Survey of Illinois, v. IV, Chapter VI, p. 90-110.

GLOSSARY

The following definitions are from several sources, in total or in part, but the main reference is *Glossary of Geology* (third edition) by Robert L. Bates and Julie A. Jackson (American Geological Institute 1987).

Age - An interval of geologic time; a division of an epoch.
Alluviated valley - A valley that has been at least partially filled with sand, silt, and mud by flowing water.
Alluvium - A general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during comparatively recent time by a stream or other body of running water as a sorted or semisorted sediment in the bed of a stream or on its floodplain or delta, etc.
Anticline - A convex upward rock fold in which strata have been bent into an arch; the strata on each side of the core of the arch are inclined in opposite directions away from the axis or crest; the core contains older rocks than does the perimeter of the structure.
Aquifer - A water-bearing geologic unit that will yield a usable quantity of water to a well or spring.
Arenite - (1) Consolidated sedimentary rocks composed of sand-sized fragments regardless of composition; (2) a nearly pure sandstone containing less than 10% argillaceous matrix; (3) a selectively and slowly deposited sediment well-washed by currents.
Argillaceous -largely composed of clay-sized particles or clay minerals.
Argillic - of or relating to clay minerals.
Base level - The lowest limit of subaerial erosion by running water. It is controlled locally and temporarily by the water level where streams enter lakes or, more generally and semipermanently, where they enter the ocean (mean sea level).
Basement complex - Largely crystalline igneous and/or metamorphic rocks, often having a complex structure and distribution, that underlie a sedimentary sequence.
Bed - A naturally occurring layer of Earth material of relatively greater horizontal than vertical extent that is characterized by physical properties that are distinctively different from those of the overlying and underlying materials. A *bed* also is the surface upon which any body of water rests or has rested, or the surface covered by the waters of a stream, lake, or ocean; the bottom of a watercourse or of a stream channel.
Bedded - Formed, arranged, or deposited in layers or beds, or made up of or occurring in the form of beds.
Bedding - The arrangement of a sedimentary rock in beds or layers of varying thickness and character.
Bedding plane - A planar or nearly planar surface, either between beds or within a bed, that visibly separates successive layers of stratified rock (of the same or different lithology) from preceding or following layers; a plane of deposition. It is often characterized by a preferred plane of breakage and may mark changes in the circumstances of deposition.
Bedrock - The solid rock that underlies the unconsolidated (non-indurated) surface materials, such as soil, alluvium, glacial drift or loess.
Bedrock valley - A drainageway eroded into the solid bedrock beneath the surface materials. It may be completely filled with unconsolidated (non-indurated) materials and hidden from view.
Bioturbation - the churning and stirring of a sediment by organisms.
Brackish - Water that is noticeably salty, but less salty than sea water.
Braided stream - A stream that flows through an intricate network of interlacing shallow channels that repeatedly merge and then divide again separated from each other by branch islands or channel bars. Such a stream is generally believed to indicate an inability to carry all of its load. Braiding commonly develops in streams subject to large fluctuations in flow volume.
Breccia - A clastic rock composed of coarse, angular rock fragments.
Calcareous - Containing calcium carbonate ($CaCO_3$); limy.
Calcarenite - Limestone composed of sand-sized grains consisting of more or less worn shell fragments or pieces of older limestone; a clastic limestone.

Calcite - A common rock-forming mineral with the chemical composition $CaCO_3$ (calcium carbonate). It is usually white, colorless, or pale shades of gray, yellow, and blue; has perfect rhombohedral cleavage; a vitreous luster, and a Moh's hardness of 3. Calcite effervesces (fizzes) readily in cold dilute hydrochloric acid. It is the principal constituent of limestone.

Carbonization - The process of concentrating residual carbon through the slow decay and fossilization of an organism or through the progressive changes that occur in the formation of coal.

Chalcedony - A "cryptocrystalline " variety of the mineral quartz (silicon dioxide; SiO_2). It commonly consists of a mass of submicroscopic crystallites that appear fibrous under a microscope. Chalcedony may be translucent or semitransparent, has a nearly wax-like luster, a uniform tint, and may be white, pale-blue, gray, brown, or black in color. It has no defined habit and commonly occurs in lumpy nodules (cf. chert; geodes).

Chert - A compact, massive rock composed of minute particles of quartz and/or chalcedony (silicon dioxide; SiO_2). It often occurs as irregular nodules and thin layers in limestone and dolomite. Flint is the name applied to chert that is dark in color.

Clastic - (adj.) Composed of detritus derived from broken fragments of preexisting rocks, including fragments of the hard parts of organisms.

Closure - In a fold, dome or other structural trap, the vertical distance between the structure's highest elevation and the lowest contour that encloses itself; used in estimating petroleum reserves.

Columnar section - A graphic representation in a vertical column of the sequence and original stratigraphic relations of the rock units in a region.

Conchoidal - (adj.) A fracture surface showing concentric rings or ridges in a shell-like or fan-shaped plan. The conchoidal fracture of flint and chert is the property exploited in making sharp stone tools.

Concretion - A localized accumulation of mineral matter in a spheroidal to irregular nodular mass.

Conglomerate - Lithified gravel; rounded pebbles cemented together.

Cryptocrystalline - (adj.) Exceedingly finely crystalline in texture and appearance with grains essentially indistinguishable even under an ordinary microscope.

Cuesta - An asymmetric hill or ridge with a long, gentle (back or dip) slope, conforming with the resistant bed(s) that form it, on one side and a steep (scarp) slope or cliff on the other, formed by the outcrop of the resistant bed(s).

Delta - A low, nearly flat, alluvial land deposited at or near the mouth of a river where it enters a body of standing water; commonly a triangular or fan-shaped plain sometimes extending beyond the general trend of the coastline. Named for its resemblance to the Greek letter (delta).

Desiccation crack - A crack in sediment produced by drying (e.g., a mud crack).

Detritus - Loose rock or mineral grains produced from older rocks by mechanical disintegration and abrasion.

Diamictite - A comprehensive, nongenetic term for a nonsorted or poorly sorted, noncalcareous, terrigenous sedimentary rock that contains a wide range of particle sizes, such as a rock consisting of sand-size and/or larger particles in a muddy matrix; e.g. a tillite or a pebbly mudstone.

Diamicton - A general term for the nonlithified equivalent of a diamictite; e.g. a till. A till is a diamicton formed by the action of a glacier. The term *till* has a genetic connotation; diamicton does not, it is purely descriptive.

Dike - A tabular, intrusive body of igneous rock that cuts across the structure of stratified, metamorphosed, or igneous rocks.

Dip slope - An inclined land surface that is parallel to the dip of the underlying stratified rocks.

Disconformity - An *unconformity* marked by a distinct, erosion-produced irregular, uneven surface of appreciable relief between parallel strata below and above the break; sometimes represents a considerable interval of nondeposition.

Distributary - An irregular, divergent stream flowing away from the main stream and not returning to it, as in a delta.

Dolomite - A mineral, calcium-magnesium carbonate [$Ca,Mg(CO_3)_2$]. It is white, colorless, or tinged yellow, brown, pink, or gray; has perfect rhombohedral cleavage; appears pearly to vitreous; effervesces feebly in cold dilute hydrochloric acid. The term is also commonly applied to those sedimentary rocks that are composed largely (more than 50%) of the mineral dolomite.

Dolostone - A rock consisting mostly (more than 50%) of the mineral dolomite. This word is sometimes used when there is a possibility of confusion in using the term *dolomite* for both the rock and the mineral.

Dome - A roughly symmetrical upfold (anticline) in which strata are inclined in all directions away from a central point.

Drift - All rock material transported by a glacier and deposited either directly by the ice or reworked and deposited by meltwater streams and/or the wind.

Driftless Area - A 10,000 square mile area in northeastern Iowa, southwestern Wisconsin, and northwestern Illinois where the absence of glacial drift suggests that the area may not have been glaciated during the Pleistocene.

Earthquake - A sudden motion or trembling in the Earth caused by the abrupt release of slowly accumulated potential energy (like that in a compressed spring) through the breaking of a rock body to form a fault, or slippage along a preexisting fault plane in the rock body.

End moraine - A ridge-like or series of ridge-like accumulations of drift built along the margin of an actively flowing glacier at any given time; a moraine that has been deposited at the lower or outer end of a glacier. (syn. *terminal moraine*)

Englacial - (adj.) Within a glacier.

Eon - The largest division of geologic time; consists of two or more eras.

Epoch - An interval of geologic time; a division of a period.

Era - A unit of geologic time that is next in magnitude beneath an eon; consists of two or more periods (e.g. Paleozoic, Mesozoic, Cenozoic).

Esker - Ridges, usually sinuous, of stratified (layered) drift (sand and gravel) in areas of ground moraine. They are deposited by, and mark the channels of, meltwater streams which flowed in, on, or under a glacier.

Estuary - The seaward end or the widened funnel-shaped tidal mouth of a river valley where it meets the sea. The part of a river where freshwater and seawater mix and where the effects of ocean tides are evident.

Facies - (1) The sum of all lithologic and paleontologic characteristics exhibited by a sedimentary rock; (2) an exclusive, mappable, and areally restricted part of a defined stratigraphic rock body; (3) a term applied to intertonguing sedimentary rock masses of differing lithologic and paleontologic characteristics, occurring within a stratigraphic unit, having irregular boundaries. The term is often used by geologists in a general sense to refer to all rocks having a common set of lithologic characteristics, or to rocks formed in a particular environment and, therefore, having a set of characteristics in common.

Fault - A fracture surface or zone in Earth materials along which there has been vertical and/or horizontal displacement or movement of the strata on both sides relative to one another. The amount of displacement may be as little as a few centimeters to as much as many kilometers.

Feldspar - Any of several abundant rock-forming minerals of the general chemical composition alkali-metal alumino-silicate [$MAl(Al,Si)_3O_8$; where M = K, Na, Ca, Ba, Rb, Sr and Fe]. They have a hardness of 6 on Moh's scale. Their normal color is translucent white or near-white, but they are commonly colored by impurities. The potash feldspars are commonly flesh-colored to red. Feldspars are the most widespread of any mineral group; they constitute about 60% of the Earth's crust. They are the primary constituents of most igneous and metamorphic rocks and are present in many sedimentary rocks. There are two major types of feldspars, the alkali or potash feldspars (e.g. orthoclase and microcline) which have potassium and sodium as their main alkali metal cations, and the plagioclase feldspars (e.g. albite, andesine, labradorite) which have sodium and calcium as their main alkali metal cations. The word feldspar is from German and means *field crystal.*

Feldspathic - (adj.) Said of a rock containing an observable quantity of feldspar, but consisting mostly of other components. Rocks that normally consist mostly of feldspar generally are not described as "feldspathic."

Ferruginous - (adj.) Pertaining to or containing iron, e.g. a sandstone that is cemented with iron oxide.

Flood plain - The surface or strip of relatively smooth land adjacent to a stream channel that has been produced by the stream's erosion and deposition actions; the area covered with water when the stream overflows its banks at times of high water. It is built of alluvium carried by the stream during floods and deposited in the sluggish water beyond the influence of the swiftest current.

Fluvial - (adj.) Of or pertaining to a river or rivers.

Fluviolacustrine - (adj.) Pertains to sedimentation partly in lake water and partly in streams, or to sediments deposited under alternating or overlapping lacustrine and fluvial conditions.

Formation - The basic rock unit distinctive enough to be readily recognizable in the field and widespread and thick enough to be plotted on a map. It describes the strata, such as limestone, sandstone, shale, or combinations of these and other rock types; formations have formal names, such as Joliet Formation or St. Louis Limestone (Formation), usually derived from geographic localities.

Geology - (a) The science of the earth; it includes, in a large sense, all aquired or possible knowledge of the natural phenomena on and within the globe. (b) Earth science including physical geology and geophysics; the history of the earth, stratigraphy and paleontology; mineralogy; petrology; and engineering, mining, and petroleum geology.

Geomorphology - A branch of both physiography and geology that deals with the form of the earth, the general configuration of its surface, and the changes that take place in the evolution of land forms.

Geophysics - The study of the Earth as a planet, generally by employing quantitative measurements of phenomena such as the Earth's electrical, magnetic and gravity fields or the movement of energy through the rocks.

Glacier - A large, slow-moving mass of ice grounded, at least in part, on land. The Arctic ice cap of the Earth is NOT a glacier because, for the most part, it is floating on the ocean surface. The Antarctic ice cap IS a glacier

Graben - A block that has moved down along bounding faults relative to the rocks on either side.

Gradient - A measurement of the degree of inclination or rate of ascent or descent of an inclined part of the Earth's surface with respect to the horizontal; commonly expressed as a ratio (ft/mi; m/km). Also, the part of a surface feature of the Earth that slopes upward or downward; a slope, as of a stream channel or of a land surface. In engineering, the synonymous term is *grade*.

Ground moraine - A sheet-like accumulation of glacial drift, principally till, deposited beneath a glacier to form an extensive area of low relief devoid of transverse linear features.

Groundwater - Water that is present below the ground surface in the soil and rocks of Earth's outer crust. Geologists generally restrict the term to that part of the subsurface water that is within the zone where the rocks are saturated with water (i.e., below the water table). Also commonly spelled as *ground water*.

Group - A geologic rock unit consisting of two or more formations.

Gypsum - A mineral having the composition hydrous calcium sulfate {$CaSO_4 2H_2O$}; it is characteristically white or colorless when pure. The most common sulfate mineral, it generally occurs in thick, extensive beds formed by the evaporation of large quantities of seawater.

Hematite - A common iron mineral having the composition ferrous oxide {Fe_2O_3}. The principal ore for iron, the mineral occurs in steel-gray or iron-black rhombohedral crystals, in globular and fibrous masses and, most commonly, in deep red to red-brown earthy forms. It has a characteristic brick red color when powdered.

Hiatus - A gap in the sedimentary record, with or without accompanying removal of sediment by erosion (signifies an unconformity).

Ice cap - A dome-shaped or plate-like cover of perennial ice and snow, covering the summit area of a mountain mass so that no peaks emerge through it, or covering a flat landmass such as an Arctic island...and having an area less than 50,000 sq. km.; it is considerably smaller than an *ice sheet*.

Ice sheet - A glacier of considerable thickness and more than 50,000 sq. km. in area, forming a continuous cover of ice and snow over a land surface spreading outward in all directions and not confined by the underlying topography; a *continental glacier*.

Igneous - (adj.) Said of a rock or mineral that has solidified from molten or partly molten material, i.e., from magma.

Indurated - (adj.) Said of a compacted rock or soil hardened by the action of pressure, cementation, and especially heat.

Joint - A fracture or crack in rocks along which there has been no significant relative movement of the rock masses on opposing sides of the crack.

Kame - A hill, mound, knob or hummock formed of poorly sorted and stratified sand and/or gravel deposited against the terminal margin of a melting glacier by a subglacial or englacial melt water stream.

Karst - A type of topography formed in areas underlain by limestone, dolomite or gypsum. Karst topography is characterized by sinkholes separated by steep ridges or irregular hills. Tunnels and caves resulting from solution by groundwater honeycomb the subsurface. Named for the Karst region of the Dinaric alps in Yugoslavia where the topography is especially well developed.

Lacustrine - (adj.) Produced by or belonging to a lake.

Laurasia - A combination of Laurentia, a paleogeographic term for the Canadian Shield and its surroundings, and Eurasia. It is the protocontinent of the Northern Hemisphere, corresponding to Gondwana in the Southern Hemisphere, from which the present continents of the Northern Hemisphere have been derived by separation and continental displacement. The hypothetical supercontinent from which both were derived is Pangea. The Laurasian protocontinent included most of North America, Greenland, and most of Eurasia, excluding India. The main zone of separation was in the North Atlantic, with a branch in Hudson Bay, and geologic features on opposite sides of these zones are very similar.

Lava - A general term for molten material extruded onto the Earth's surface from a volcano; also, applies to the rock that solidified from the extruded material.

Limestone - A sedimentary rock consisting primarily (more than 50%) of calcium carbonate $CaCO_3$ (the mineral, calcite). Most limestones were deposited in the ocean and consist primarily of fragments of the hard parts of living organisms.

Litharenite - A sandstone, regardless of texture, containing more than 25% fine-grained rock fragments, less than 10% of the feldspar minerals, and less than 75% quartz, quartzite, and chert.

Lithify - (v.) To change to stone, or to petrify; esp. to consolidate from a loose sediment to a solid rock.

Lithology - The description of a rock on the basis of its color, particle size, mineral composition, bedding and other directly observable characteristics; the physical character of a rock.

Local relief - The vertical difference in elevation between the highest and lowest points of a land surface within a specified horizontal distance or within a limited area.

Loess - A homogeneous, unstratified deposit of silt deposited by the wind.

Magma - Naturally occurring mobile rock material, generated within Earth and capable of intrusion and extrusion, from which igneous rocks are thought to have been derived through solidification and related processes.

Marble - Metamorphosed limestone or dolostone generally with a more or less coarse-grained crystalline texture.

Meander - One of a series of somewhat regular, sharp, sinuous curves, bends, loops, or turns produced by a stream, particularly in its lower course where its channel swings from side to side across its valley bottom.

Meander scars - Crescent-shaped, concave marks along a river's floodplain that mark the positions of abandoned meanders. Although generally filled in with sediments and vegetation, they are generally low swales and may contain water during wet seasons. Often invisible from the ground, they make striking patterns when viewed from the air, and may also be readily apparent on topographic maps.

Metamorphic rock - Any rock derived from pre-existing rocks through mineralogical and structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment at depth in Earth's crust (e.g. gneiss, schist, slate, marble, quartzite, etc.).

Metamorphism - The processes by which metamorphic rocks are formed and the changes in a preexisting rock induced by those processes. In general, metamorphism does not alter the chemical composition of the preexisiting rock either by introducing new material or by extracting material. The processes of metamorphism only rearrange the preexisting chemical elements in the rock from one set of minerals to a new set of minerals more closely in equilibrium with the new temperature and pressure conditions imposed on the rock.

Mica - Any of the members of a group of minerals known as phyllosilicates (having sheet-like structures) that can be easily split apart into thin, tough, slightly bendable sheets. The micas are common minerals in igneous and metamorphic rocks and can range in color from colorless through yellow, green, brown or black. The most common members of the family are muscovite (colorless to pale yellow) and biotite (dark brown to black).

Micaceous - (adj.) Said of an Earth material containing an observable amount of mica.

Monocline - Strata inclined in a single direction, such as a step-like fold or downwarp.

Moraine - A mound, ridge, or other distinct accumulation of glacial drift, predominantly till, deposited chiefly by the direct action of glacial ice in a variety of topographic landforms whose position and shape are not affected by the topography of the former land surface on which the drift lies.

Morphology - The scientific study of form, and of the structures and development that influence form; term used in most sciences.

Neap tide - A tide having an unusually small or reduced tide range (usually 10-30% less than the mean range). Such tides occur when the Moon and Sun are at right angles to each other with respect to the Earth (quadrature).

Nonconformity - An unconformity resulting from the deposition of sedimentary strata on top of older crystalline rocks that have been exposed to weathering and erosion. The general term *unconformity* is currently used more commonly.

Normal fault - A fault in which the hanging wall (the rock mass above the fault plane) has moved downward relative to the foot wall (the rock mass below the fault plane).

Outwash - Stratified detritus (gravel, sand, silt and clay) that was "washed out" from a glacier by meltwater streams and deposited in channels, deltas, outwash plains, floodplains, and lakes in front of (beyond) the terminal moraine or the margin of an active glacier.

Outwash plain - The surface formed by a broad body of outwash deposited in front of a glacier.

Overburden - Barren rock material, either loose or consolidated, overlying a mineral deposit, which must be removed prior to mining.

Oxbow lake - A crescent-shaped lake in an abandoned meander of a river channel.

Paleosol - A buried soil horizon of the geologic past. When uncovered, it is said to be exhumed. (Syn.: buried soil; fossil soil).

Pangea - A hypothetical supercontinent; supposed by many geologists to have existed at an early time in the geologic past, and to have combined all the continental crust of the Earth, from which the present continents were derived by fragmentation and movement away from each other by means of some form of continental displacement. During an intermediate stage of the fragmentation, between the existence of Pangea and that of the present widely separated continents, Pangea was supposed to have split into two large fragments, *Laurasia* on the north and *Gondwana* on the south. The proto-ocean around Pangea has been termed *Panthalassa*. Other geologists, while believing in the former existence of Laurasia and Gond-

MISSISSIPPIAN DEPOSITION

(The following quotation is from Report of Investigations 216: Classification of Genevievian and Chesterian...Rocks of Illinois [1965] by D. H. Swann, pp. 11-16. One figure and short sections of the text are omitted.)

During the Mississippian Period, the Illinois Basin was a slowly subsiding region with a vague north-south structural axis. It was flanked by structurally neutral regions to the east and west, corresponding to the present Cincinnati and Ozark Arches. These neighboring elements contributed insignificant amounts of sediment to the basin. Instead, the basin was filled by locally precipitated carbonate and by mud and sand eroded from highland areas far to the northeast in the eastern part of the Canadian Shield and perhaps the northeastward extension of the Appalachians. This sediment was brought to the Illinois region by a major river system, which it will be convenient to call the Michigan River (fig. 4) because it crossed the present state of Michigan from north to south or northeast to southwest....

The Michigan River delivered much sediment to the Illinois region during early Mississippian time. However, an advance of the sea midway in the Mississippian Period prevented sand and mud from reaching the area during deposition of the St. Louis Limestone. Genevievian time began with the lowering of sea level and the alternating deposition of shallow-water carbonate and clastic units in a pattern that persisted throughout the rest of the Mississippian. About a fourth of the fill of the basin during the late Mississippian was carbonate, another fourth was sand, and the remainder was mud carried down by the Michigan River.

Thickness, facies, and crossbedding...indicate the existence of a regional slope to the southwest, perpendicular to the prevailing north 65° west trend of the shorelines. The Illinois Basin, although developing structurally during this time, was not an embayment of the interior sea. Indeed, the mouth of the Michigan River generally extended out into the sea as a bird-foot delta, and the shoreline across the basin area may have been convex more often than concave.

....The shoreline was not static. Its position oscillated through a range of perhaps 600 to 1000 or more miles. At times it was so far south that land conditions existed throughout the present area of the Illinois Basin. At other times it was so far north that there is no suggestion of near-shore environment in the sediments still preserved. This migration of the shoreline and of the accompanying sedimentation belts determined the composition and position of Genevievian and Chesterian rock bodies.

Lateral shifts in the course of the Michigan River also influenced the placement of the rock bodies. At times the river brought its load of sediment to the eastern edge of the basin, at times to the center, and at times to the western edge. This lateral shifting occurred within a range of about 200 miles. The Cincinnati and Ozark areas did not themselves provide sediments, but, rather, the Michigan River tended to avoid those relatively positive areas in favor of the down-warped basin axis.

Sedimentation belts during this time were not symmetrical with respect to the mouth of the Michigan River. They were distorted by the position of the river relative to the Ozark and Cincinnati shoal areas, but of greater importance was sea current or drift to the northwest. This carried off most of the mud contributed by the river, narrowing the shale belt east of the river mouth and broadening it west

of the mouth. Facies and isopach maps of individual units show several times as much shale west of the locus of sand deposition as east of it. The facies maps of the entire Chesterian...show maximum sandstone deposition in a northeast-southwest belt that bisects the basin. The total thickness of limestone is greatest along the southern border of the basin and is relatively constant along that entire border. The proportion of limestone, however, is much higher at the eastern end than along the rest of the southern border, because little mud was carried southeastward against the prevailing sea current. Instead, the mud was carried to the northwest and the highest proportion of shale is found in the northwestern part of the basin.

Genevievian and Chesterian seas generally extended from the Illinois Basin eastward across the Cincinnati Shoal area and the Appalachian Basin. Little terrigeneous sediment reached the Cincinnati Shoal area from either the west or the east, and the section consists of thin limestone units representing all or most of the major cycles. The proportion of inorganically precipitated limestone is relatively high and the waters over the shoal area were commonly hypersaline... Erosion of the shoal area at times is indicated by the presence of conodonts eroded from the St. Louis Limestone and redeposited in the lower part of the Gasper Limestone at the southeast corner of the Illinois Basin...

The shoal area included regions somewhat east of the present Cincinnati axis and extended from Ohio, and probably southeastern Indiana, through central and east-central Kentucky and Tennessee into Alabama....

Toward the west, the seaway was commonly continuous between the Illinois Basin and central Iowa, although only the record of Genevievian and earliest Chesterian is still preserved. The seas generally extended from the Illinois and Black Warrior regions into the Arkansas Valley region, and the presence of Chesterian outliers high in the Ozarks indicates that at times the Ozark area was covered. Although the sea was continuous into the Ouachita region, detailed correlation of the Illinois sediments with the geosynclinal deposits of this area is difficult.

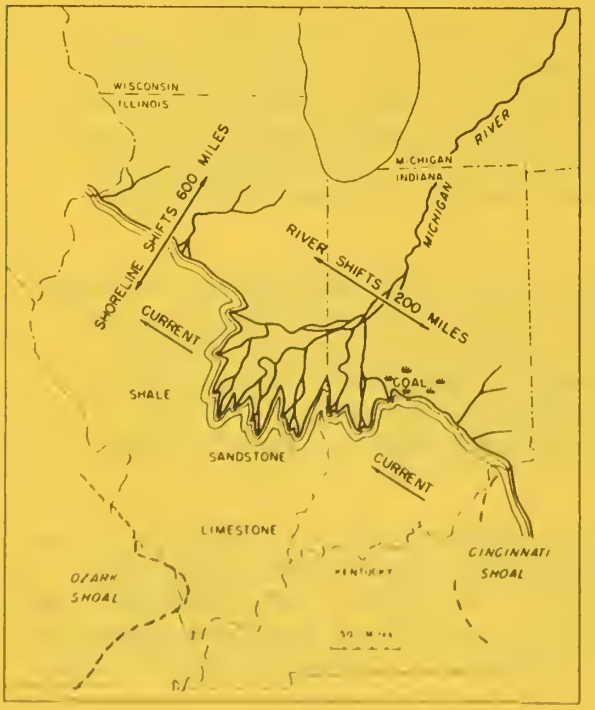


Figure 4: Paleogeography at an intermediate stage during Chesterian sedimentation.

DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS IN ILLINOIS

At the close of the Mississippian Period, about 310 million years ago, the sea withdrew from the Midcontinent region. A long interval of erosion that took place early in Pennsylvanian time removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. Ancient river systems cut deep channels into the bedrock surface. Later, but still during early Pennsylvanian (Morrowan) time, the sea level started to rise; the corresponding rise in the base level of deposition interrupted the erosion and led to filling the valleys in the erosion surface with fluvial, brackish, and marine sands and muds.

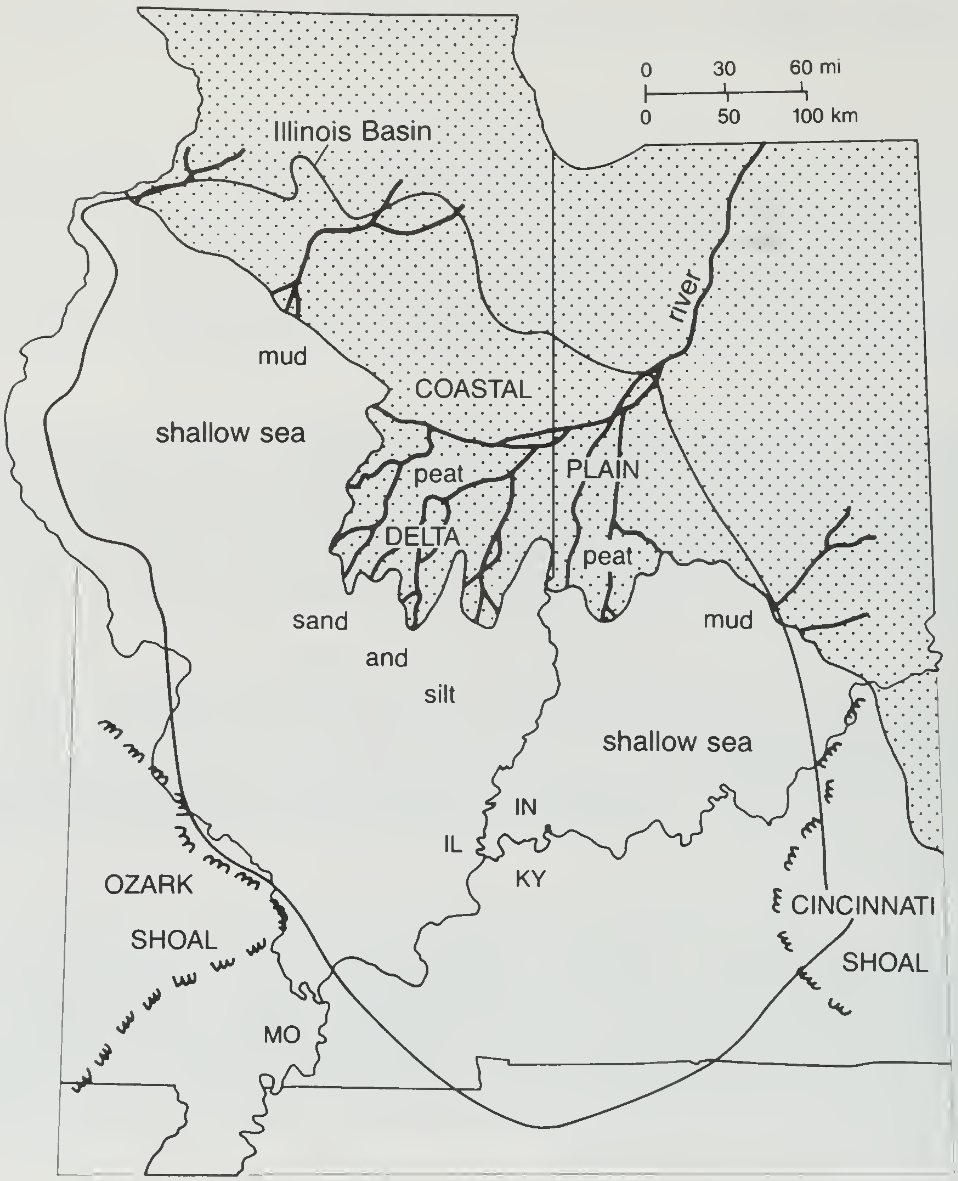
Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those of the preceding Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands to the northeast. This river system formed thin but widespread deltas that coalesced into a vast coastal plain or lowland that prograded (built out) into the shallow sea that covered much of present-day Illinois (see paleogeographic map, next page). As the lowland stood only a few feet above sea level, slight changes in relative sea level caused great shifts in the position of the shoreline.

During most of Pennsylvanian time, the Illinois Basin gradually subsided; a maximum of about 3000 feet of Pennsylvanian sediments are preserved in the basin. The locations of the delta systems and the shoreline of the resulting coastal plain shifted, probably because of worldwide sea level changes, coupled with variation in the amounts of sediments provided by the river system and local changes in basin subsidence rates. These frequent shifts in the coastline position caused the depositional conditions at any one locality in the basin to alternate frequently between marine and nonmarine, producing a variety of lithologies in the Pennsylvanian rocks (see lithology distribution chart).

Conditions at various places on the shallow sea floor favored the deposition of sand, lime mud, or mud. Sand was deposited near the mouths of distributary channels, where it was reworked by waves and spread out as thin sheets near the shore. Mud was deposited in quiet-water areas — in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Limestone was formed from the accumulation of limy parts of plants and animals laid down in areas where only minor amounts of sand and mud were being deposited. The areas of sand, mud, and limy mud deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sand, mud, and lime mud were deposited on the coastal plain bordering the sea. The nonmarine sand was deposited in delta distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies 100 or more feet thick were deposited in channels that cut through the underlying rock units. Mud was deposited mainly on floodplains. Some mud and freshwater lime mud were deposited locally in fresh-water lakes and swamps.

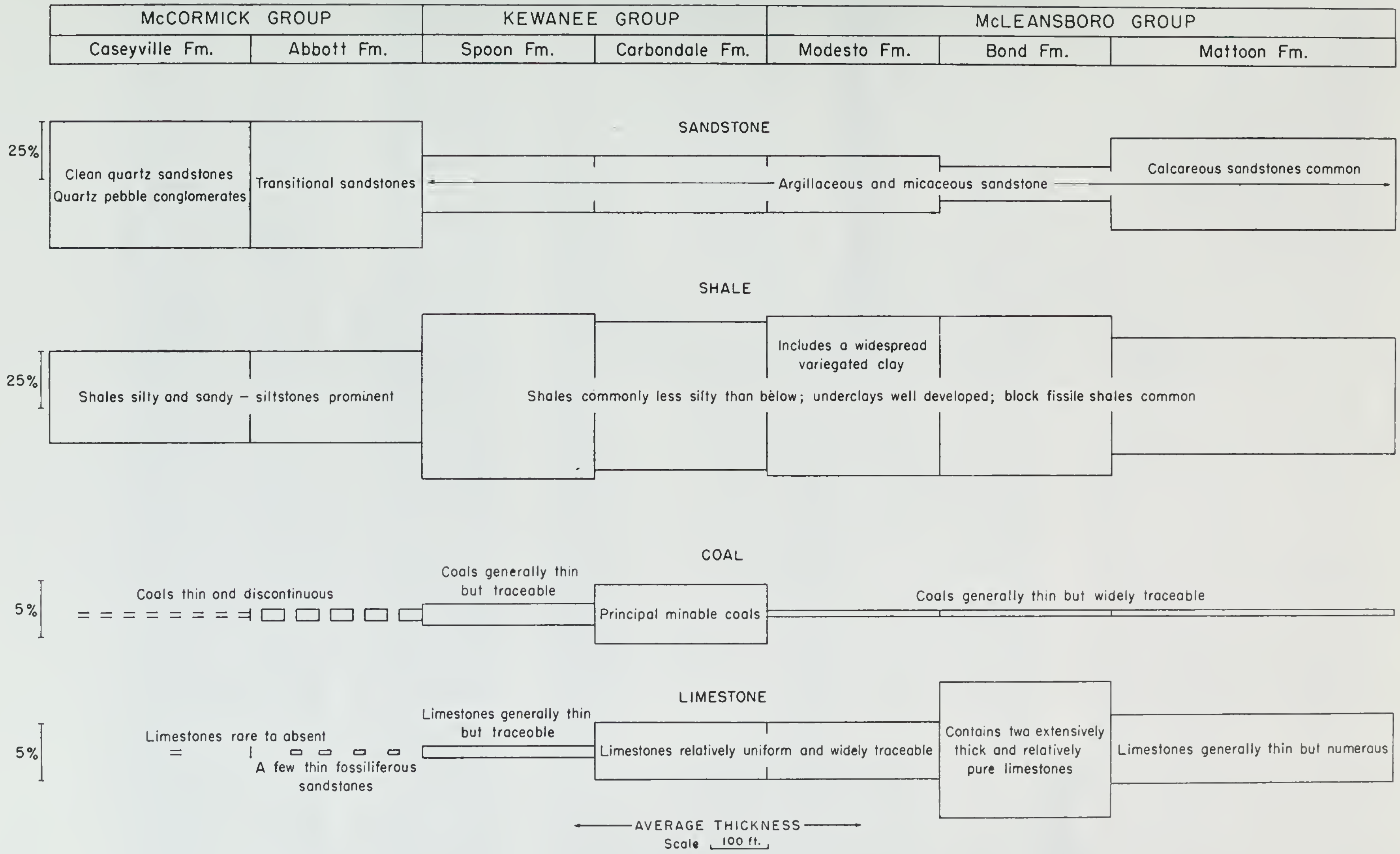
Beneath the quiet water of extensive swamps that prevailed for long intervals on the emergent coastal lowland, peat was formed by accumulation of plant material. Lush forest vegetation covered the region; it thrived in the warm, moist Pennsylvanian-age climate. Although the origin of the underclays beneath the coal is not precisely known, most evidence indicates that they were deposited in the swamps as slackwater mud before the accumulation of much plant debris. The clay underwent modification to become the soil upon which the lush vegetation grew in the swamps. Underclay frequently contains plant roots and rootlets that appear to be in their original places. The vast swamps were the culmination of nonmarine deposition. Resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were laid down over the peat.



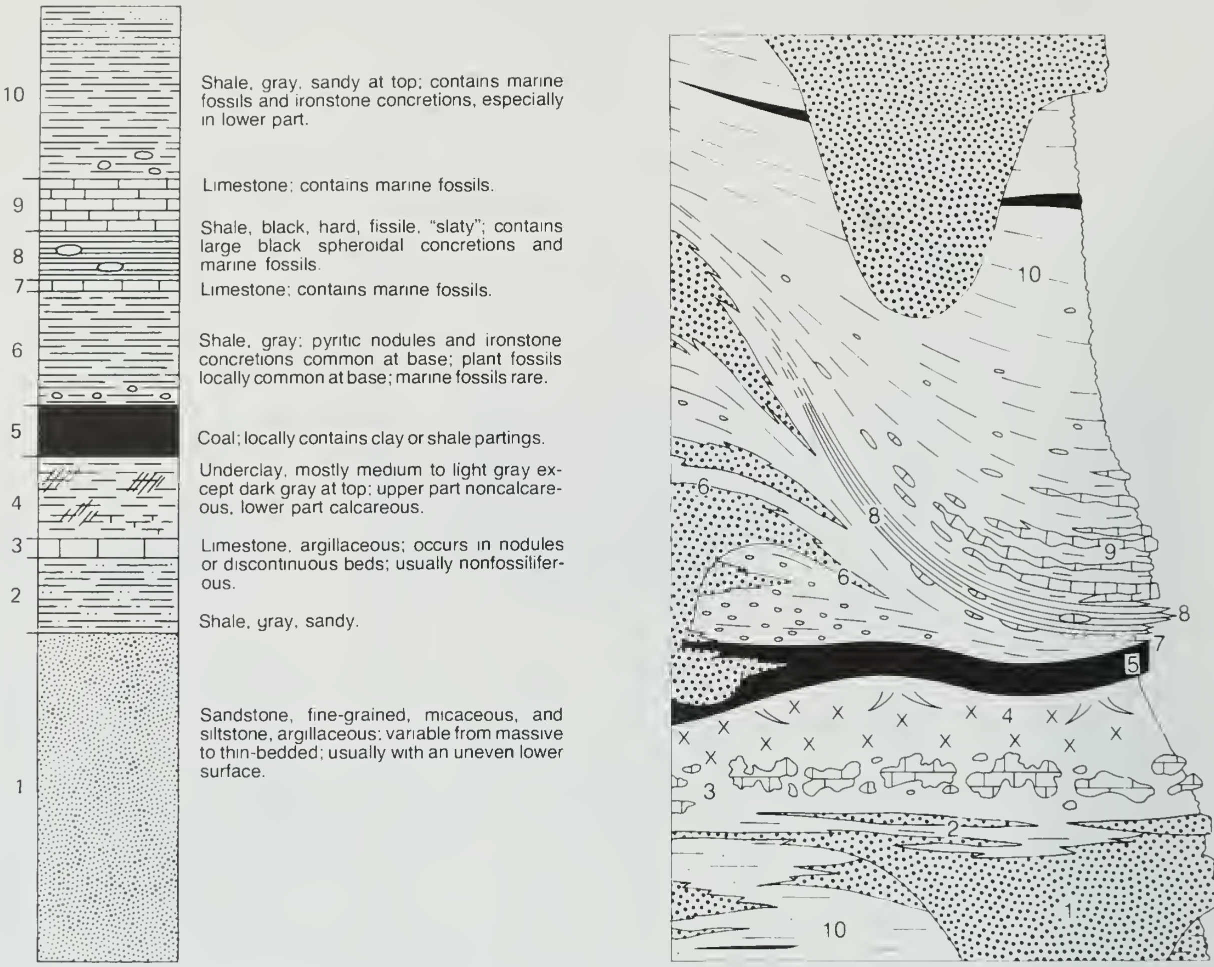
Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows a Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

Pennsylvanian Cyclothems

The Pennsylvanian strata exhibit extraordinary variations in thickness and composition both laterally and vertically because of the extremely varied environmental conditions under which they formed. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and some limestones, however, display remarkable lateral continuity for such thin units. Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.



General distribution of the four principal lithologies in Pennsylvanian strata of Illinois.



The idealized cyclothem at left (after Willman and Payne, 1942) infers continuous, widespread distribution of individual cyclothem units, at right the model of a typical cyclothem (after Baird and Shabica, 1980) shows the discontinuous nature of many units in a cyclothem.

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting shoreline. Each series of alternations, called a cyclothem, consists of several marine and nonmarine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an "ideally" complete cyclothem consists of ten sedimentary units (see illustration above contrasting the model of an "ideal" cyclothem with a model showing the dynamic relationships between the various members of a typical cyclothem).

Approximately 50 cyclothems have been described in the Illinois Basin but only a few contain all ten units at any given location. Usually one or more are missing because conditions of deposition were more varied than indicated by the "ideal" cyclothem. However, the order of units in each cyclothem is almost always the same: a typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheety shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal-gray shale portion (the lower six units) of each cyclothem is nonmarine: it was deposited as part of the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal and gray shale are marine sediments deposited when the sea advanced over the coastal plain.

Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh-to-brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothems. The swamps occupied vast areas of the coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm, humid Pennsylvanian climate. (Illinois at that time was near the equator.) The deciduous trees and flowering plants that are common today had not yet evolved. Instead, the jungle-like forests were dominated by giant ancestors of present-day club mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate (tropical). Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

Plant debris from the rapidly growing swamp forests — leaves, twigs, branches, and logs — accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably stagnant and low in oxygen, prevented oxidation, and any decay of the peat deposits was due primarily to bacterial action.

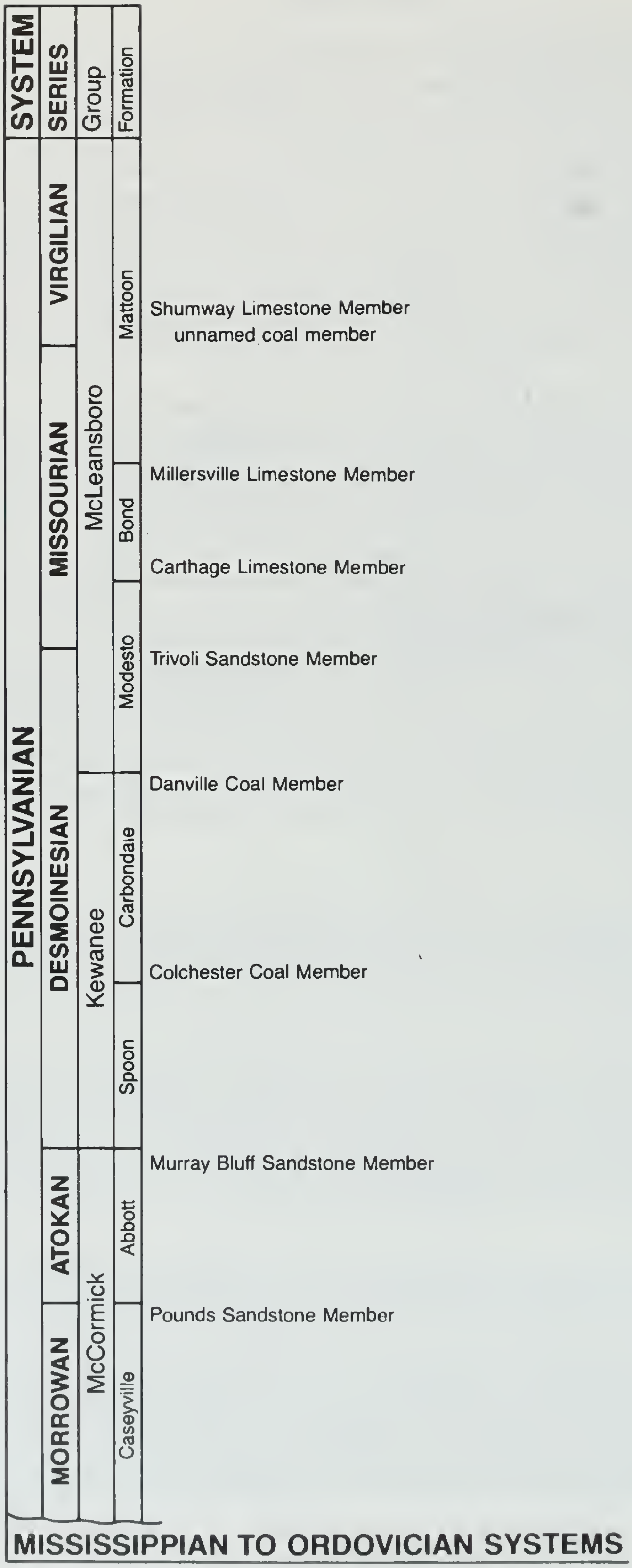
The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests, and the peat deposits were often buried by marine sediments. After the marine transgressions, peat usually became saturated with sea water containing sulfates and other dissolved minerals. Even the marine sediments being deposited on the top of the drowned peat contained various minerals in solution, including sulfur, which further infiltrated the peat. As a result, the peat developed into a coal that is high in sulfur. However, in a number of areas, nonmarine muds, silts, and sands from the river system on the coastal plain covered the peat where flooding broke through levees or the river changed its coarse. Where these sediments (unit 6 of the cyclothem) are more than 20 feet thick, we find that the coal is low in sulfur, whereas coal found directly beneath marine rocks is high in sulfur. Although the seas did cover the areas where these nonmarine, fluvial sediments covered the peat, the peat was protected from sulfur infiltration by the shielding effect of these thick fluvial sediments.

Following burial, the peat deposits were gradually transformed into coal by slow physical and chemical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coal-forming ("coalification") process, and the peat deposits were changed into coal.

Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shale that occurs above many coals is uncertain. Current thinking suggests that the black shale actually represents the deepest part of the marine transgression. Maximum transgression of the sea, coupled with upwelling of ocean water and accumulation of mud and animal remains on an anaerobic ocean floor, led to the deposition of black organic mud over vast areas stretching from Texas to Illinois. Deposition occurred in quiet-water areas where the very fine-grained iron-rich



Generalized stratigraphic column of the Pennsylvanian in Illinois (1 inch = approximately 250 feet).

mud and finely divided plant debris were washed in from the land. Most of the fossils found in black shale represent planktonic (floating) and nektonic (swimming) forms — not benthonic (bottom-dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shale formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient water of the lagoons. However, study has shown that the "depauperate" fauna consists mostly of normal-size individuals of species that never grew any larger.

References

Baird, G. C., and C. W. Shabica, 1980, The Mazon Creek depositional event; examination of Francis Creek and analogous facies in the Midcontinent region: *in* Middle and late Pennsylvanian strata on margin of Illinois Basin, Vermilion County, Illinois, Vermilion and Parke counties, Indiana (R. L. Langenheim, editor). Annual Field Conference — Society of Economic Paleontologists and Mineralogists. Great Lakes Section, No. 10, p. 79-92.

Heckel, P. H., 1977, Origin of phosphatic black shale facies in Pennsylvanian cyclothems of mid-continent North America: American Association of Petroleum Geologist Bulletin, v. 61, p. 1045-1068.

Kosanke, R. M., J. A. Simon, H. R. Wanless, and H. B. Willman, 1960, Classification of the Pennsylvanian strata of Illinois: Illinois State Geological Survey Report of Investigation 214, 84 p.

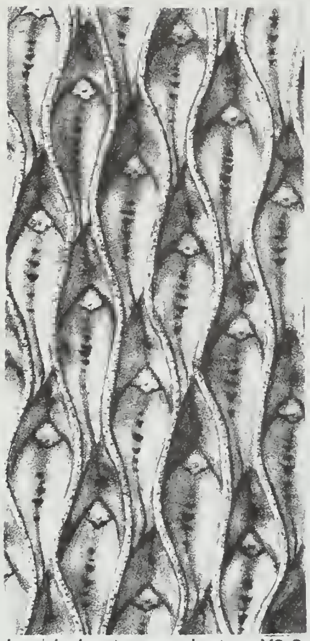
Simon, J. A., and M. E. Hopkins, 1973, Geology of Coal: Illinois State Geological Survey Reprint 1973-H, 28 p.

Willman, H. B., and J. N. Payne, 1942, Geology and mineral resources of the Marseilles, Ottawa, and Streator Quadrangles: Illinois State Geological Survey Bulletin 66, 388 p.

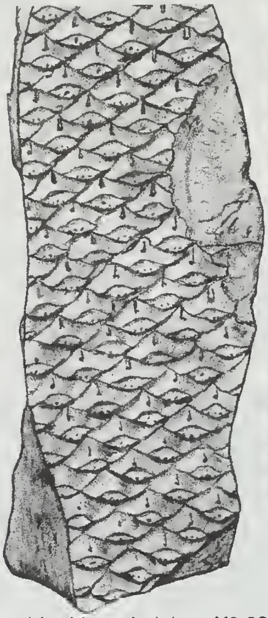
Willman, H. B., et al., 1967, Geologic Map of Illinois: Illinois State Geological Survey map; scale, 1:500,000 (about 8 miles per inch).

Willman, H. B., E. Atherton, T. C. Buschbach, C. W. Collinson, J. C. Frye, M. E. Hopkins, J. A. Lineback, and J. A. Simon, 1975, Handbook of Illinois Stratigraphy: Illinois State Geological Survey Bulletin 95, 261 p.

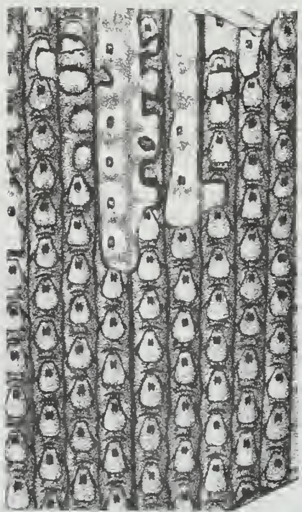
Common Pennsylvanian plants: lycopods, sphenophytes, and ferns



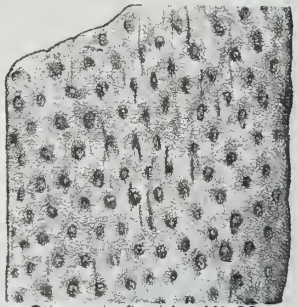
Lepidodendron aculeatum X0.8



Lepidophloios laricinus X0.63

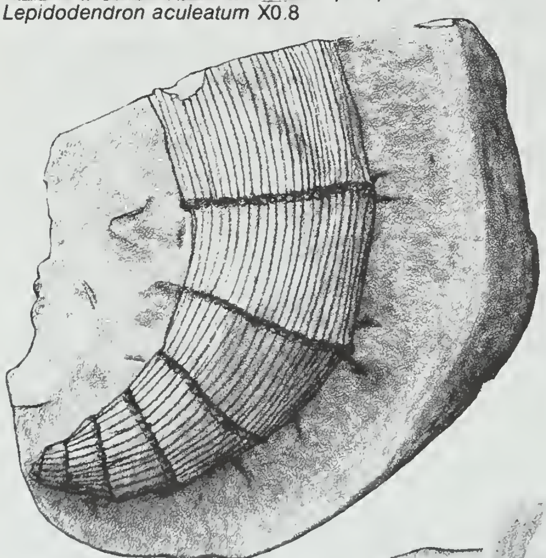


Sigillaria mammilaris X0.5

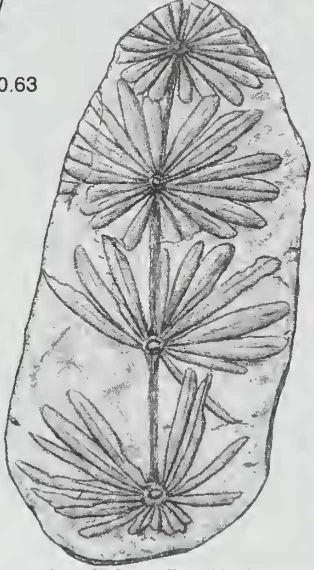


Stigmaria ficoides X0.32

Lepidostrobus ovatifolius X0.8

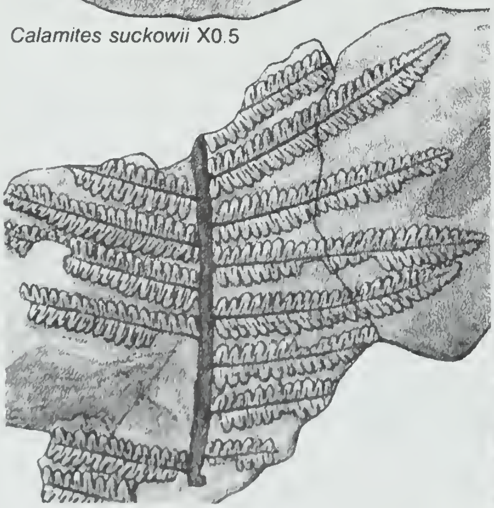


Calamites suckowii X0.5



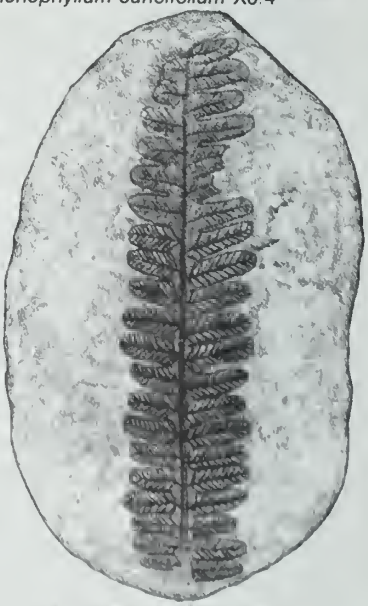
Annularia stellata X0.63

Sphenophyllum cuneifolium X0.4



Pecopteris sp. X0 32

Pecopteris miltonii X2.0



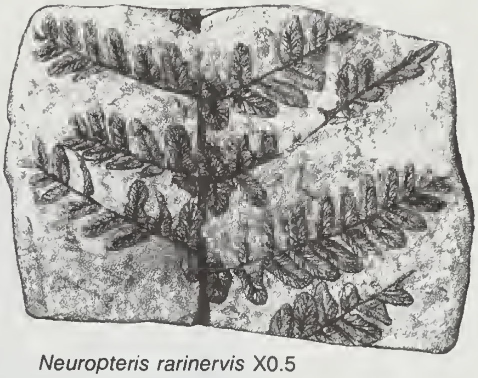
Pecopteris hemitelioides X1.0

J R Jennings, ISGS

Common Pennsylvanian plants: seed ferns and cordaiteans

Alethopteris serlii X0.63

Alethopteris ambigua X0.63

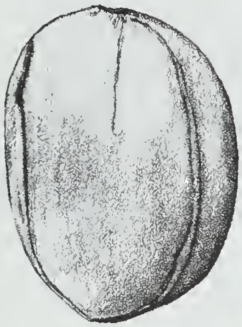


Neuropteris rarinervis X0.5

Mariopteris nervosa X0.8

Neuropteris scheuchzeri X0.63

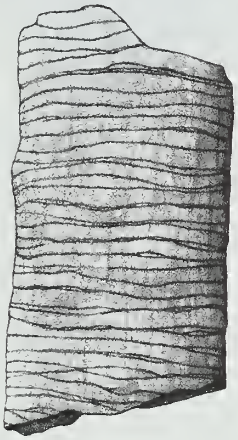
Sphenopteris rotundiloba X0.8



Trigonocarpus parkinsonii X1.25

Cordaites principalis X0.63

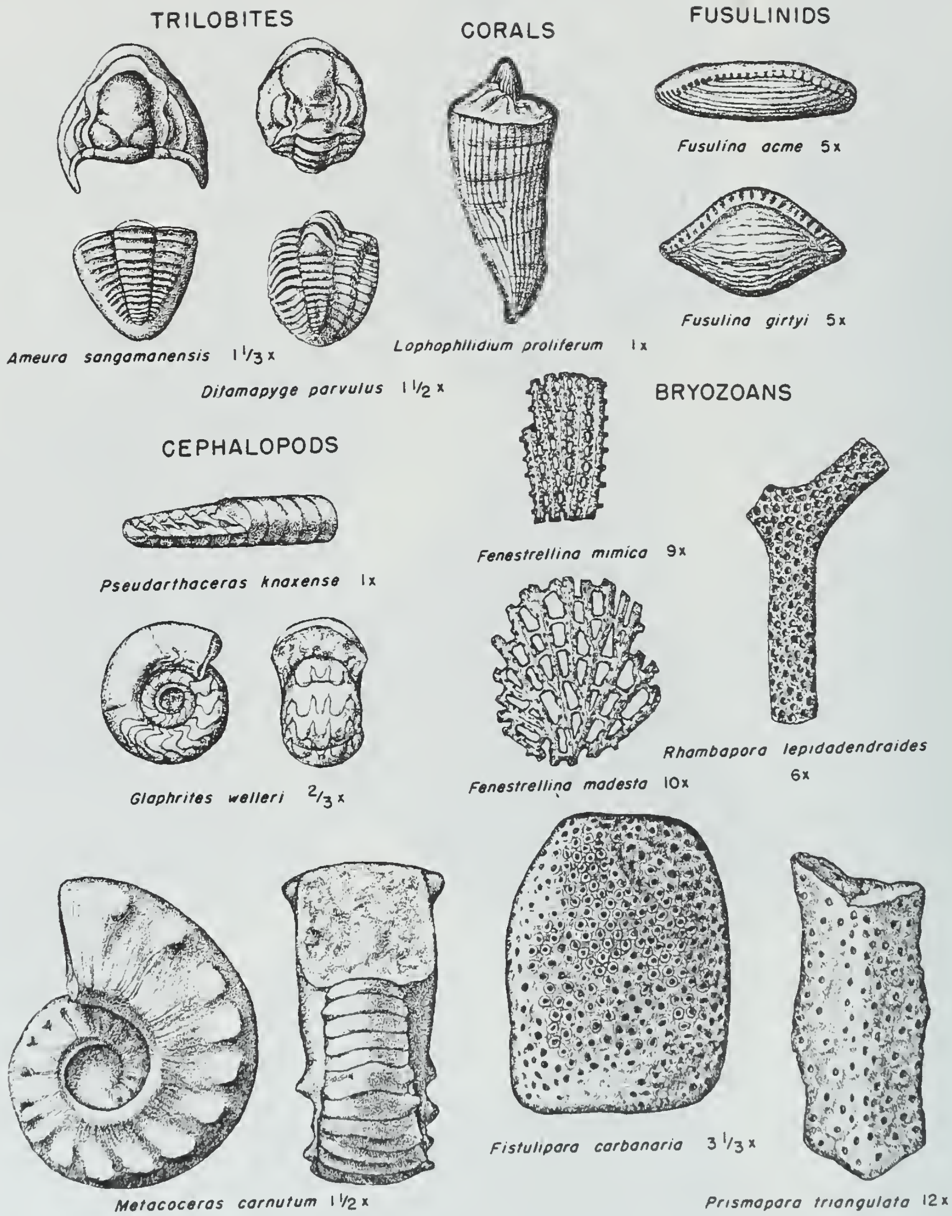
Cordaicladus sp. X1.0

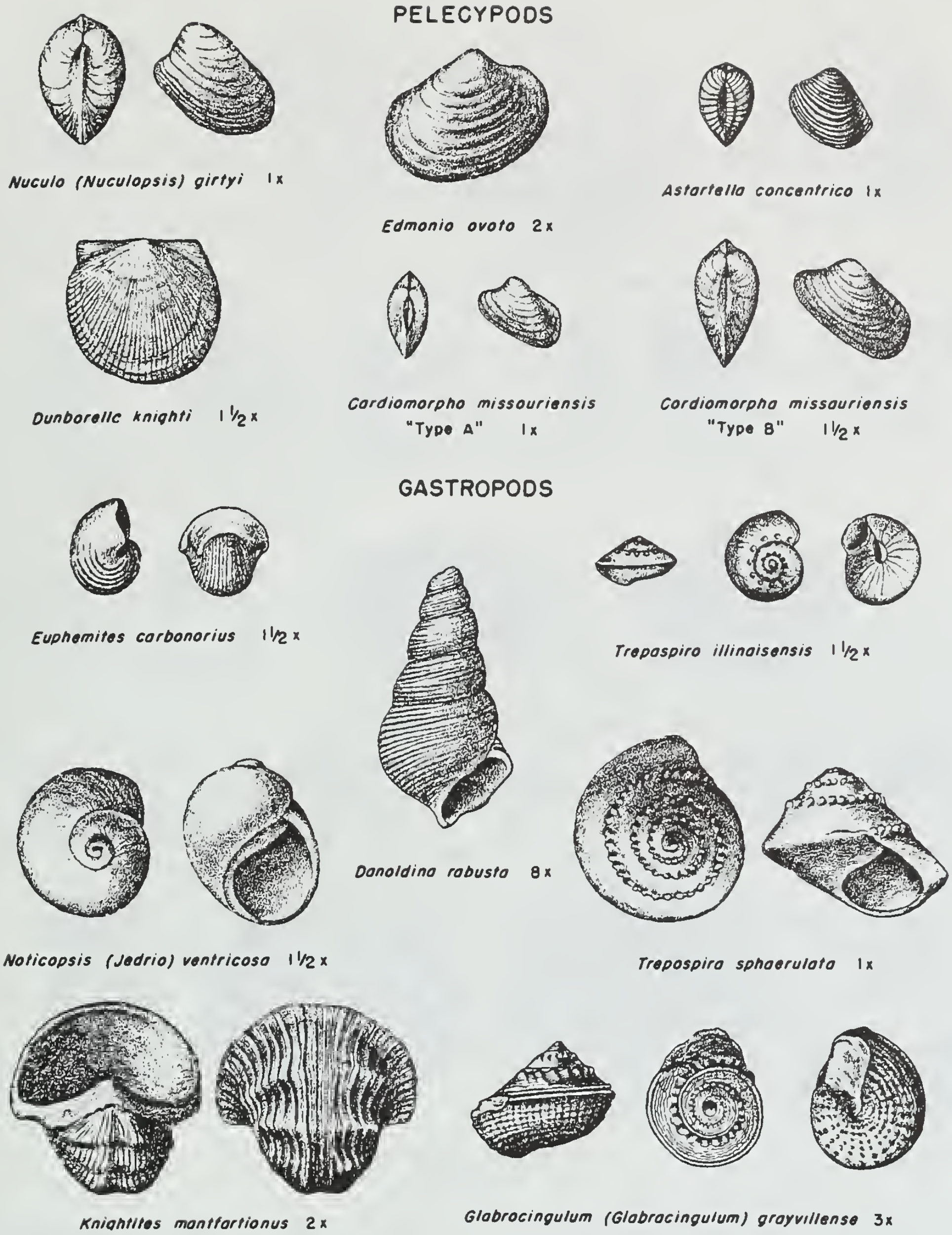


Artisia transversa X0.63

Cordaicarpon major X2.0

J. R. Jennings, ISGS


TRILOBITES
CORALS
FUSULINIDS
Fusulina acme 5x
Fusulina girtyi 5x
Ameura sangamonensis 1 1/3 x
Lophophllidium proliferum 1x
Ditomopyge parvulus 1 1/2 x
BRYOZOANS
CEPHALOPODS
Pseudorthoceras knoxense 1x
Fenestrellina mimica 9x
Glaphrites welleri 2/3 x
Fenestrellina modesta 10x
Rhombopora lepidodendroides 6x
Metacoceras cornutum 1 1/2 x
Fistulipora carbonaria 3 1/3 x
Prismopora triangulata 12x



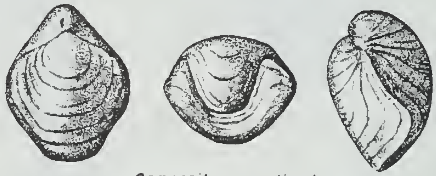
PELECYPODS
Nucula (Nuculopsis) girtyi 1x
Edmondia ovata 2x
Astartella concentrica 1x
Dunbarella knighti 1 1/2 x
Cardiomorpha missouriensis "Type A" 1x
Cardiomorpha missouriensis "Type B" 1 1/2 x
GASTROPODS
Euphemites carbonarius 1 1/2 x
Trepospira illinoisensis 1 1/2 x
Donaldina robusta 8x
Naticopsis (Jedria) ventricosa 1 1/2 x
Trepospira sphaerulata 1x
Knightites montfortianus 2x
Glabrocingulum (Glabrocingulum) grayvillense 3x

BRACHIOPODS

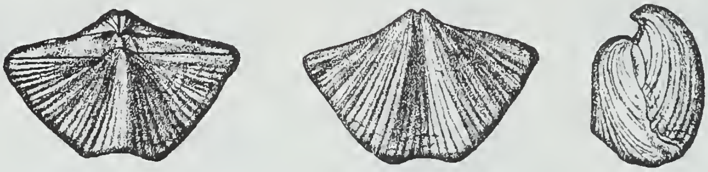
Wellerella tetrahedra 1½ x

Juresania nebrascensis ⅔ x

Derbya crassa 1x

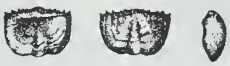


Composita argentia 1x



Neospirifer cameratus 1x

Chonetes granulifer 1½ x



Mesolobus mesolobus var. *euampygus* 2x

Marginifera splendens 1x

Crurithyris planoconvexa 2x

Linoproductus "cora" 1x

PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, an interval of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. The cooling of the earth's surface, a prerequisite for glaciation, began at least 2 million years ago. On the basis of evidence found in subpolar oceans of the world (temperature-dependent fossils and oxygen-isotope ratios), a recent proposal has been made to recognize the beginning of the Pleistocene at 1.6 million years ago. Ice sheets formed in sub-arctic regions many times and spread outward until they covered the northern parts of Europe and North America. In North America, early studies of the glacial deposits led to the model that four glaciations could explain the observed distribution of glacial deposits. The deposits of a glaciation were separated from each other by the evidence of intervals of time during which soils formed on the land surface. In order of occurrence from the oldest to the youngest, they were given the names Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. Work in the last 30 years has shown that there were more than four glaciations but the actual number and correlations at this time are not known. Estimates that are gaining credibility suggest that there may have been about 14 glaciations in the last one million years. In Illinois, estimates range from 4 to 8 based on buried soils and glacial deposits. For practical purposes, the previous four glacial stage model is functional, but we now know that the older stages are complex and probably contain more than one glaciation. Until we know more, all of the older glacial deposits, including the Nebraskan and Kansan will be classified as pre-Illinoian. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.

The North American ice sheets developed when the mean annual temperature was perhaps 4° to 7°C (7° to 13°F) cooler than it is now and winter snows did not completely melt during the summers. Because the time of cooler conditions lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was enough to lower the sea level from 300 to 400 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the buried deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called **drift**. Drift that is ice-laid is called **till**. Water-laid drift is called **outwash**.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also stratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders. For descriptive purposes, a mixture of clay, silt, sand and boulders is called **diamicton**. This is a term used to describe a deposit that could be interpreted as till or a mass wasting product.

Tills may be deposited as **end moraines**, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as **ground moraines**, or **till plains**, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called **outwash**. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size—the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits in some places. In general, outwash tends to be coarser and less weathered, and alluvium is most often finer than medium sand and contains variable amounts of weathered material.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an **esker**. Some eskers in Illinois are made up of sandy to silty deposits and contain mass wasted diamicton material. Cone-shaped mounds of coarse outwash, called **kames**, were formed where meltwater plunged through crevasses in the ice or into ponds on the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake rapidly lost speed and also quickly dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were commonly redistributed on the lake bottom by wind-generated currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an **outwash plain**. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississiippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as **valley trains**. Valley train deposits may be both extensive and thick. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess, Eolian Sand and Soils

One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. **Loess** is the name given to windblown deposits dominated by silt. Most of the silt was derived from wind erosion of the valley trains. Wind action also sorted out **eolian sand** which commonly formed **sand dunes** on the valley trains or on the adjacent uplands. In places, sand dunes have migrated up to 10 miles away from the principle source of sand. Flat areas between dunes are generally underlain by eolian **sheet sand** that is commonly reworked by water action. On uplands along the major valley trains, loess and eolian sand are commonly interbedded. With increasing distance from the valleys, the eolian sand pinches out, often within one mile.

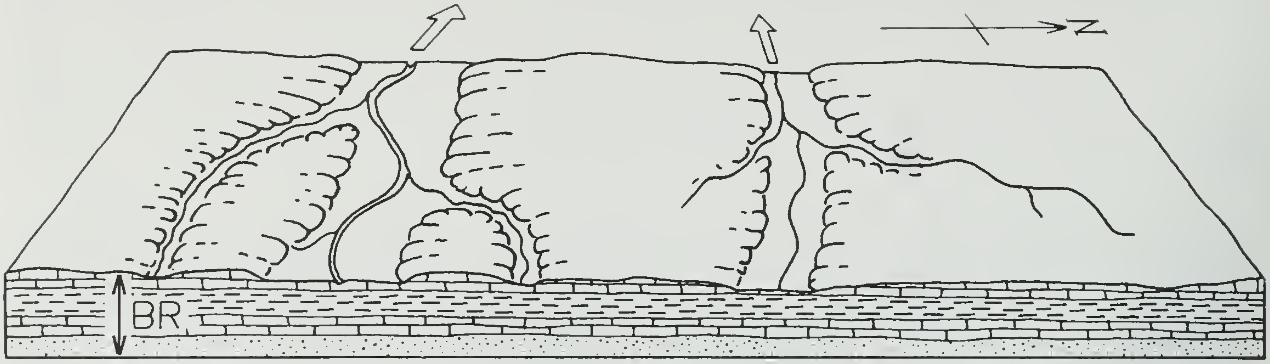
Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but some were buried. Those that survive serve as "key beds," or stratigraphic markers, and are evidence of the passage of a long interval of time.

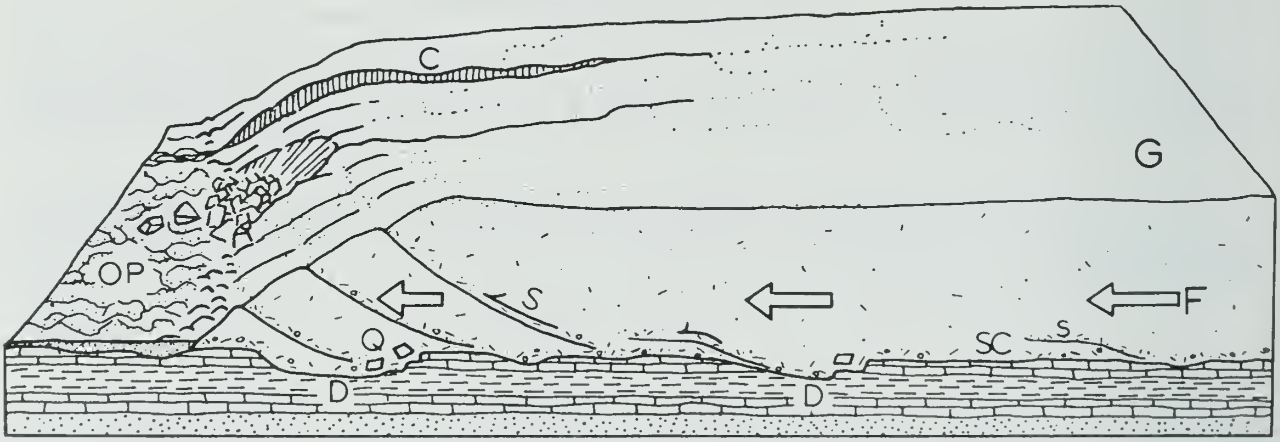
Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked at various stages as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

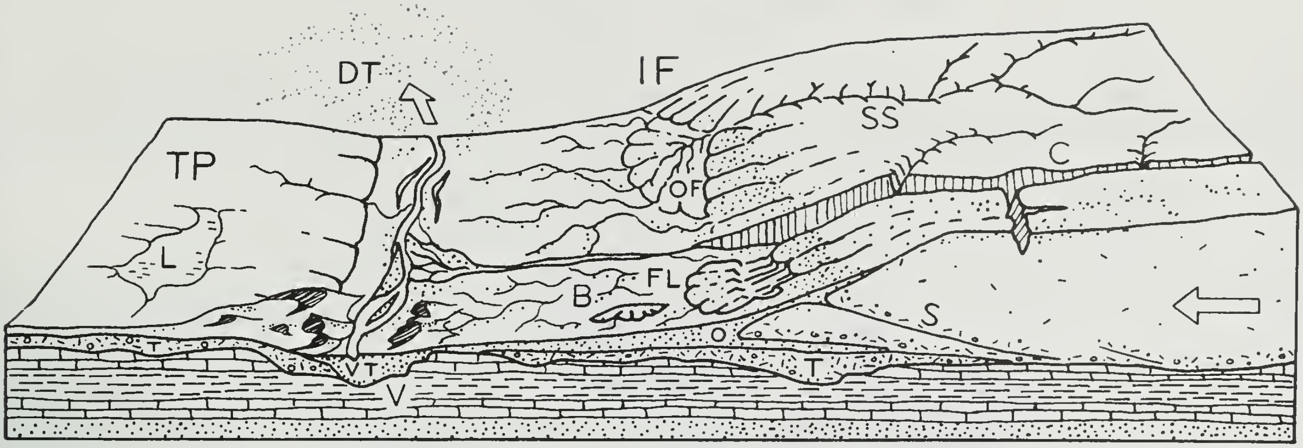
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



1. **The Region Before Glaciation** — Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks—layers of sandstone ( ), limestone ( ), and shale ( ). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



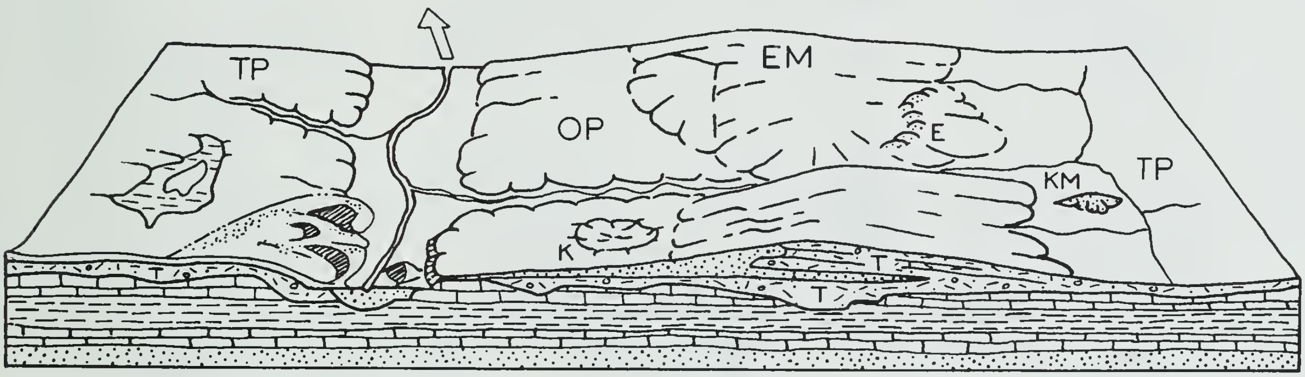
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick, and tapers to the margin, which was probably in the range of several hundred feet above the old terrain. The ice front advances perhaps as much as a third of a mile per year.



3. **The Glacier Deposits an End Moraine** — After the glacier advances across the area, the climate warms and the ice begins to melt as fast as it advances. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that is mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A supraglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) remains as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remains a low spot in the terrain. As soon as the ice cover melts, meltwater drains down the valley, cutting it deeper. Later, outwash partly refills the valley: the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles. Sand dunes (D) form on the south and east sides of streams.



4. **The Region after Glaciation** — As the climate warms further, the whole ice sheet melts, and glaciation ends. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

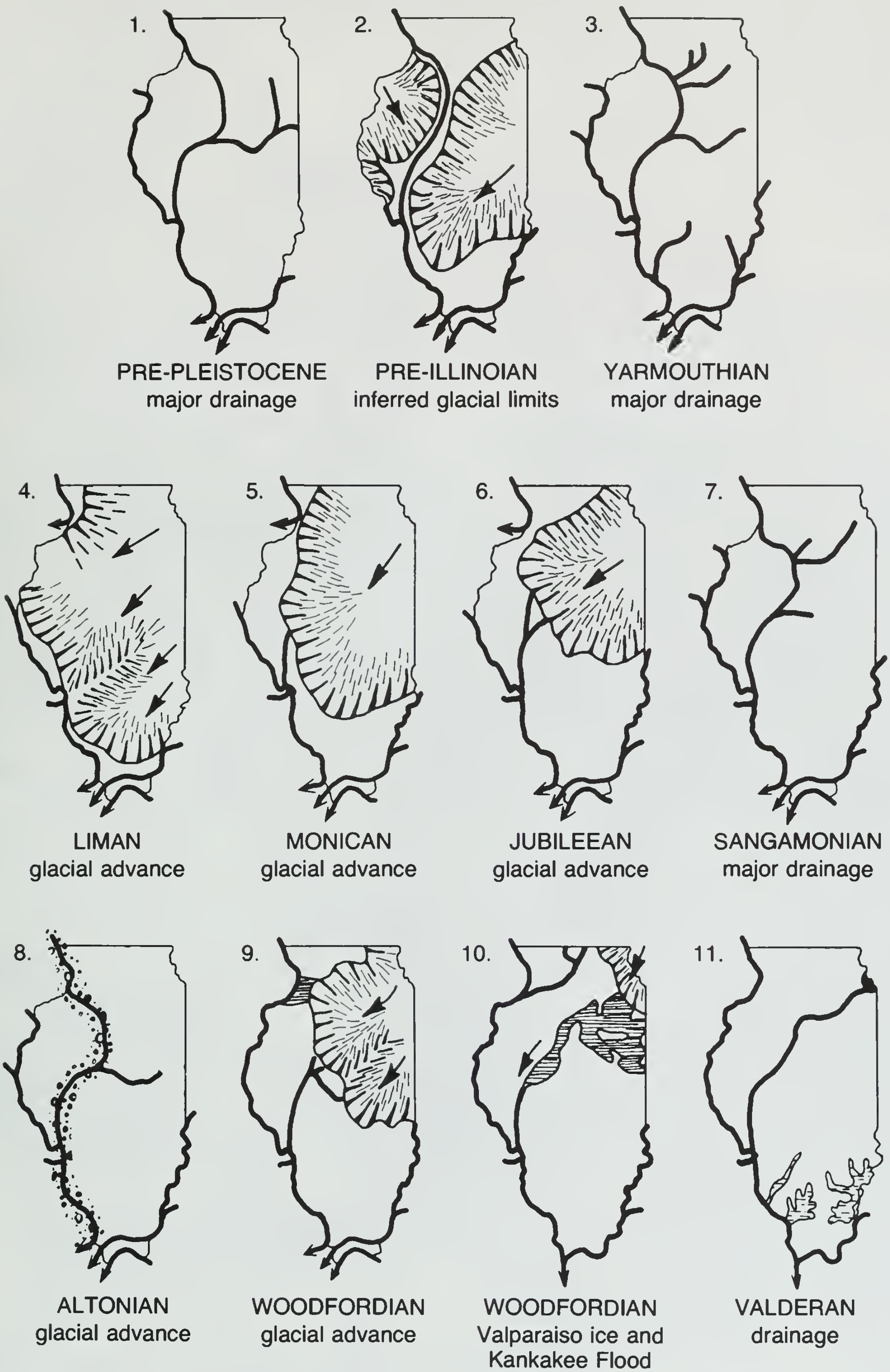
TIME TABLE OF PLEISTOCENE GLACIATION

			STAGE		SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
QUATERNARY			HOLOCENE (interglacial)		Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
					10,000		
	Pleistocene		WISCONSINAN (glacial)	late	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
					11,000		
					Twocreekan	Peat and alluvium	Ice withdrawal, erosion
					12,500		
					Woodfordian	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
					25,000		
				mid	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion
					28,000		
				early	Altonian	Drift, loess	Glaciation in Great Lakes area, valley trains along major rivers
					75,000		
			SANGAMONIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
					125,000		
			ILLINOIAN (glacial)		Jubileean	Drift, loess, outwash	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
					Monican	Drift, loess, outwash	
					Liman	Drift, loess, outwash	
					300,000?		
			YARMOUTHIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
					500,000?		
		Pre-Illinoian	KANSAN* (glacial)			Drift, loess	Glaciers from northeast and northwest covered much of state
					700,000?		
			AFTONIAN* (interglacial)			Soil, mature profile of weathering	(hypothetical)
					900,000?		
			NEBRASKAN* (glacial)			Drift (little known)	Glaciers from northwest invaded western Illinois
					1,600,000 or more		

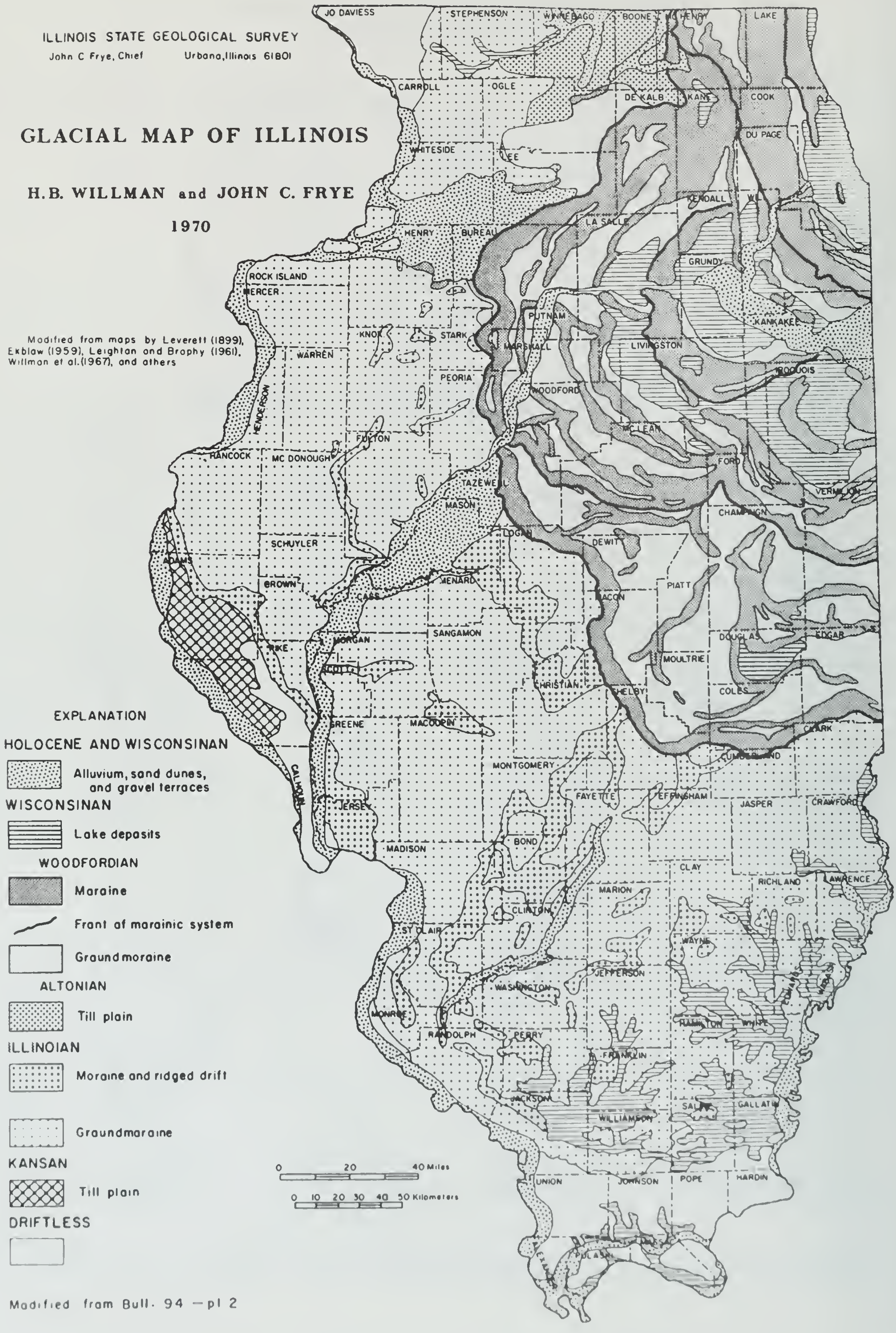
*Old oversimplified concepts, now known to represent a series of glacial cycles.

(Illinois State Geological Survey, 1973

SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS



(Modified from Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)

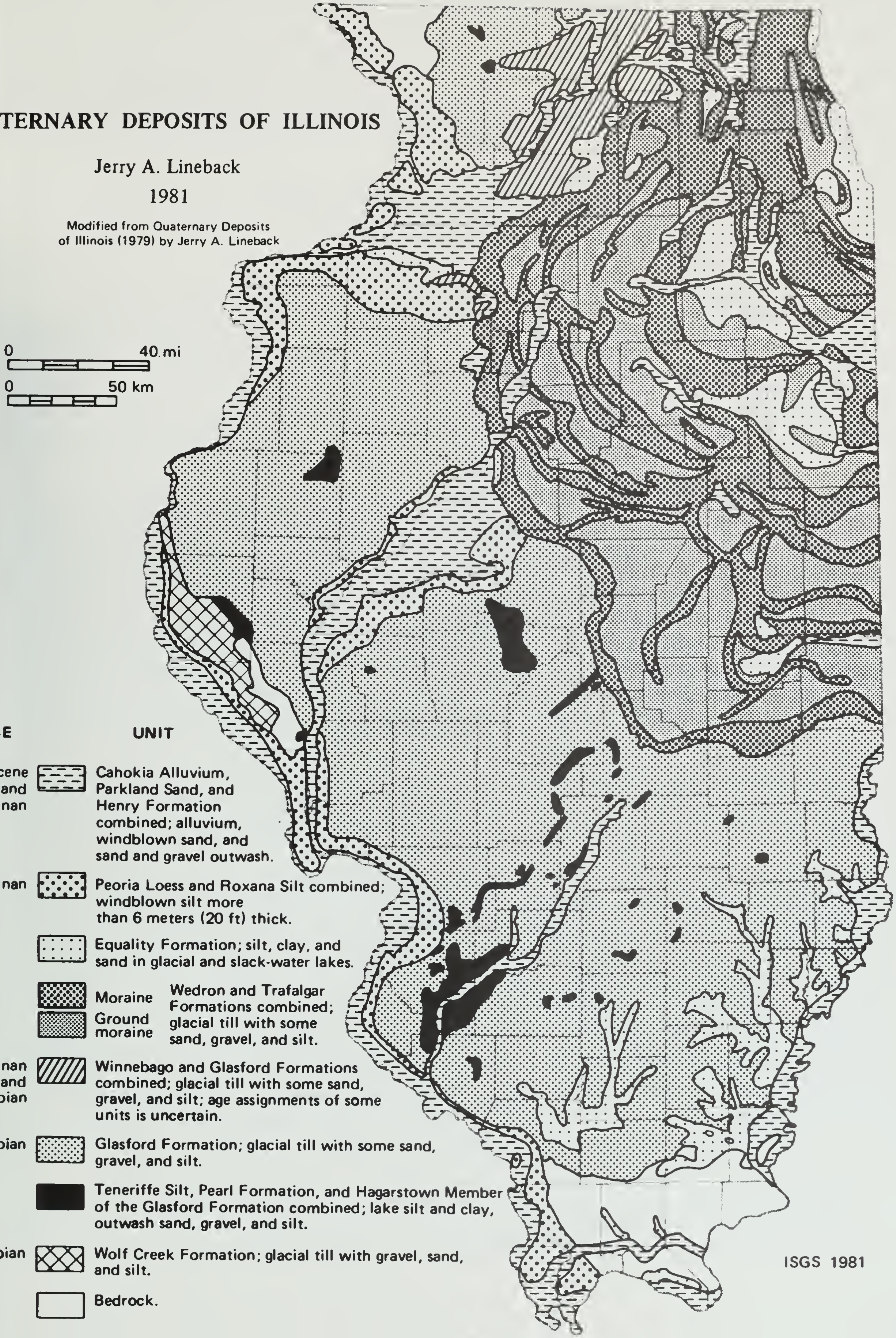

ILLINOIS STATE GEOLOGICAL SURVEY
John C Frye, Chief Urbana, Illinois 61801
GLACIAL MAP OF ILLINOIS
H.B. WILLMAN and JOHN C. FRYE
1970
Modified from maps by Leverett (1899), Ekblaw (1959), Leighton and Brophy (1961), Willman et al. (1967), and others
EXPLANATION
HOLOCENE AND WISCONSINAN
Alluvium, sand dunes, and gravel terraces
WISCONSINAN
Lake deposits
WOODFORDIAN
Moraine
Front of morainic system
Groundmoraine
ALTONIAN
Till plain
ILLINOIAN
Moraine and ridged drift
Groundmoraine
KANSAN
Till plain
DRIFTLESS
0 20 40 Miles
0 10 20 30 40 50 Kilometers
Modified from Bull. 94 — pl 2
JO DAVIESS
STEPHENSON
WINNEBAGO
BOONE
MC HENRY
LAKE
CARROLL
OGLE
DE KALB
KANE
COOK
DU PAGE
WHITESIDE
LEE
KENDALL
LA SALLE
HENRY
BUREAU
GRUNDY
ROCK ISLAND
MERCER
PUTNAM
KANKAKEE
KNOX
STARK
MARSHALL
LIVINGSTON
WARREN
PEORIA
IROQUOIS
HENDERSON
WOODFORD
FULTON
MC LEAN
HANCOCK
MC DONOUGH
FORD
TAZEWELL
MASON
VERMILION
CHAMPAIGN
LOGAN
DEWITT
SCHUYLER
ADAMS
BROWN
MENARD
CASS
PIATT
MACON
SANGAMON
MORGAN
PIKE
SCOTT
DOUGLAS
EDGAR
MOULTRIE
CHRISTIAN
SHELBY
COLES
GREENE
MACOUPIN
CLARK
CUMBERLAND
MONTGOMERY
CALHOUN
FAYETTE
EFFINGHAM
JASPER
CRAWFORD
JERSEY
BOND
MADISON
CLAY
RICHLAND
LAWRENCE
MARION
CLINTON
ST CLAIR
WAYNE
JEFFERSON
WASHINGTON
EDWARDS
WABASH
MONROE
RANDOLPH
PERRY
HAMILTON
WHITE
FRANKLIN
JACKSON
WILLIAMSON
SALINE
GALLATIN
UNION
JOHNSON
POPE
HARDIN
PULASKI
ALEXANDER

QUATERNARY DEPOSITS OF ILLINOIS

Jerry A. Lineback

1981

Modified from Quaternary Deposits of Illinois (1979) by Jerry A. Lineback



ILLINOIS STATE GEOLOGICAL SURVEY
Urbana, Illinois 61801

GEOGRAM 5
October 1975

ANCIENT DUST STORMS IN ILLINOIS

Myrna M. Killey

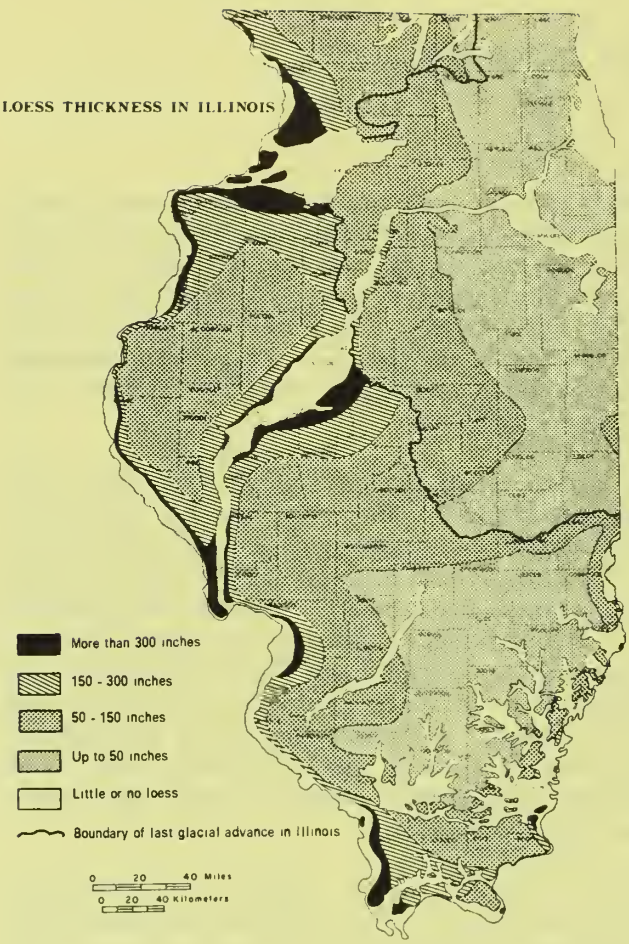
Fierce dust storms whirled across Illinois long before human beings were here to record them. Where did all the dust come from? Geologists have carefully put together clues from the earth itself to get the story. As the glaciers of the Great Ice Age scraped and scoured their way southward across the landscape from Canada, they moved colossal amounts of rock and earth. Much of the rock ground from the surface was kneaded into the ice and carried along, often for hundreds of miles. The glaciers acted as giant grist mills, grinding much of the rock and earth to "flour"—very fine dust-sized particles.

During the warm seasons, water from the melting ice poured from the glacier front, laden with this rock flour, called silt. In the cold months the meltwater stopped flowing and the silt was left along the channels the water had followed, where it dried out and became dust. Strong winds picked up the dust, swept it from the floodplains, and carried it to adjacent uplands. There the forests along the river valleys trapped the dust, which became part of the moist forest soil. With each storm more material accumulated until the high bluffs adjacent to major rivers were formed. The dust deposits are thicker along the eastern sides of the valleys than they are on the western sides, a fact from which geologists deduce that the prevailing winds of that time blew from west to east, the same direction as those of today. From such clues geologists conclude that the geologic processes of the past were much like those of today.

The deposits of windblown silt are called loess (rhymes with "bus"). Loess is found not only in the areas once covered by the glaciers but has been blown into the nonglaciated areas. The glaciers, therefore, influenced the present land surface well beyond the line of their farthest advance.

Loess has several interesting characteristics. Its texture is so fine and uniform that it can easily be identified in roadcuts—and because it blankets such a vast area many roads are cut through it. Even more noticeable is its tendency to stand in vertical walls. These steep walls develop as the loess drains and becomes tough, compact, and massive, much like a rock. Sometimes cracks develop in the loess, just as they do in massive limestones and sandstones. Loess makes good highway banks if it is cut vertically. A vertical cut permits maximum drainage because little surface is exposed to rain, and rainwater tends to drain straight down through it to the rock underneath. If the bank is cut at an angle more water soaks in, which causes the loess to slump down. Along Illinois roads the difference between a loess roadcut and one in ordinary glacial till is obvious. The loess has a very uniform texture, while the till is composed of a random mixture of rock debris, from clay and silt through cobbles and boulders.

Many loess deposits are worth a close look. Through a 10-power hand lens separate grains can be seen, among them many clear, glassy, quartz grains. Some loess deposits contain numerous rounded, lumpy stones called concretions. Their formation began when water percolating through the loess dissolved tiny

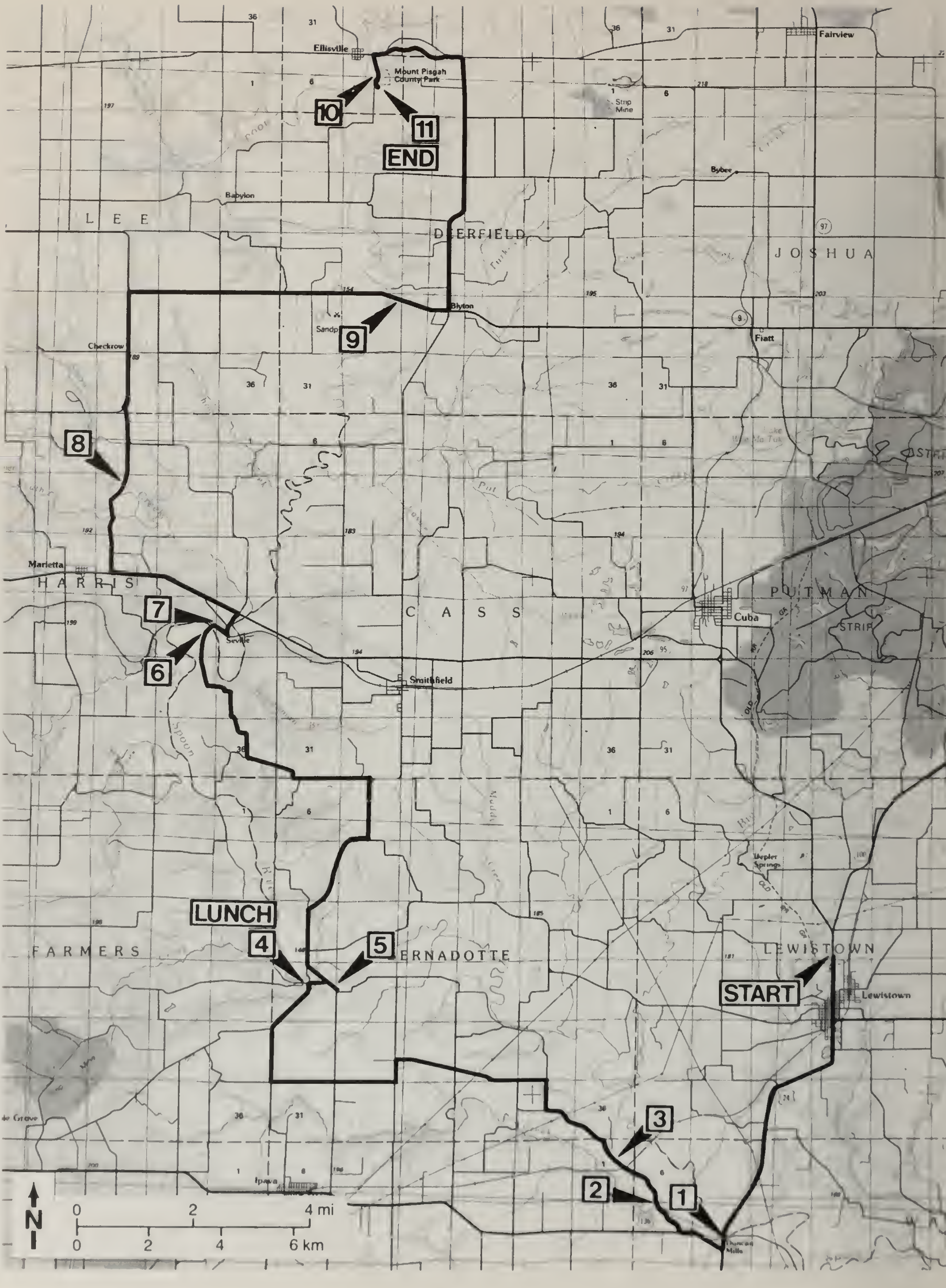


limestone grains. Some of the dissolved minerals later became solid again, gathering around a tiny nucleus or along roots to form the lumpy masses. A few such concretions are shaped roughly like small dolls and, from this resemblance, are called "loess kindchen," a German term meaning "loess children." They may be partly hollow and contain smaller lumps that make them rattle when shaken.

Fossil snails can be found in some loess deposits. The snails lived on the river bluffs while the loess was being deposited and were buried by the dust. When they are abundant, they are used to determine how old the loess is. The age is found by measuring the amount of radioactive carbon in the calcium carbonate of their shells.

Some of the early loess deposits were covered by new layers of loess following later glacial invasions. Many thousands of years passed between the major glacial periods, during which time the climate was as warm as that of today. During the warm intervals, the surface of the loess and other glacial deposits was exposed to weather. Soils developed on most of the terrain, altering the composition, color, and texture of the glacial material. During later advances of the ice, some of these soils were destroyed, but in many places they are preserved under the younger sediments. Such ancient buried soils can be used to determine when the materials above and below them were laid down by the ice and what changes in climate took place.

The blanket of loess deposited by the ancient dust storms forms the parent material of the rich, deep soils that today are basic to the state's agriculture. A soil made of loess crumbles easily and has great moisture-holding capacity. It also is free from rocks that might complicate cultivation. Those great dust storms that swirled over the land many thousands of years ago thus endowed Illinois with one of its greatest resources, its highly productive soil.



Ellisville
Mount Pisgah County Park
Fairview
Strip Mine
10
11
END
Bybee
Babylon
LEE
DEERFIELD
JOSHUA
Blyton
Sandp
9
Fiatt
Checkrow
8
Marietta
HARRIS
CASS
PUTMAN
Cuba
STRIP
7
Seville
6
Smithfield
Spoon
Depler Springs
LUNCH
4
5
FARMERS
BERNADOTTE
LEWISTOWN
START
Lewistown
3
2
1
Ipava
Duncan Mills
N
0
2
4 mi
0
2
4
6 km